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THE SOURCE OF ANIMALS MOVING INTO A DEPOPULATED AREA

BY LUCILLE F. STICKEL

The present study was made to determine the number of wood mice (*Peromyscus leucopus*) that will re-invade a continuously trapped plot, and to discover where these animals come from, whether they have previously established home ranges, and in what proportions the invading animals are males, females, and juveniles.

Acknowledgments are made to Mr. Clyde Vance for able assistance in the field work, to Mr. James Cope for help during the live-trapping, and to Mrs. K. C. Tabb for preparation of the base map.

METHODS

The work was a continuation of an experiment for the comparison of census methods. This was reported on in a separate paper (Stickel 1946) which contains full details of the experiment, a description of the experimental area, and other pertinent matters, so the methods will be outlined very briefly here.

A typical section of bottomland forest on the Patuxent Research Refuge, Bowie, Maryland, was the site of the study. In the midst of a continuous area of wooded bottomlands, 293 Sherman live-traps were set at 50-foot intervals on a 17-acre study plot. Trapping was carried on for 7 nights, September 4 to September 10, 1945, during which time all wood mice captured were marked with an ear-punch toe-clip system so as to be individually recognizable, and released where taken.

Following this live-trapping, a 1-acre plot in the center of the larger 17-acre area was set with a saturation number (200) of snap-traps. This central 1-acre was snap-trapped continuously for 35 nights, September 12 to October 16, 1945. Traps were removed from the plot until November 17, 1945, when they were replaced for a 3-night trapping period. The area was similarly trapped again March 7 to March 9, 1946. Traps were baited with rolled oats and peanut butter throughout the experiment.

RESULTS OF LIVE-TRAPPING

A total of 139 adult wood mice were taken 393 times during the 7 nights of live-trapping on the 17-acre plot. Maps were constructed showing the localities and dates at which each of the mice was taken, and from this data it was possible to

see what parts of the 17-acre plot represented the home areas of the individual mice, and also to determine the number of animals using the area and to express these results in terms of wood mice per acre.

It was calculated that there were between 6 and 7 adult mice per acre on this 17-acre tract. Nearly equal numbers of males and females were present. Female mice had home-ranges averaging about 100 feet in diameter, while the ranges of male mice were a little larger, about 150 feet in diameter. These figures are based on those animals that were taken at least 4 different times, as data on animals taken less than 4 times suggested lesser movements, whereas records for

TABLE 1.—*Results of saturation snap-trapping of Peromyscus on one acre of bottomland forest*

DATE (1945)	MARKED			NEW JUV.
	♂	♀	Juv.	
September 12	6	8	2	—
13	3	2	1	1
14	4	0	0	2
16	5	1	1	1
17	2	0	1	2
18	4	2*	0	1
19	0	0	0	1
21	2	0	0	1
22	1	0	0	2
24	1	0	0	0
25	1	0	0	0
26	1	2	0	1
27	1	0	0	1
28	1	0	0	0
29	1	0	0	0
October 2	0	2	0	1
3	1	1	0	0
8	0	0	0	2
9	1	0	0	0
16	1	0	0	1
Total	36	18	5	17

* Not shown on maps because partial damage to ears prevented accurate reading of the numbers.

those caught 5, 6 or 7 times indicated about the same radius of activity as those taken 4 times. A more detailed account of these live-trapping results, and the methods of making the calculations are given in the previously cited paper.

The home-range sizes found in the live-trapping period are probably close to normal, on the average, because they are of the same magnitude as those determined by Burt (1940) for the same species, and also are the same as were found in studies made by other methods on the Patuxent Refuge. Nevertheless, it should be noted that on the maps in Figures 1 and 2, the outlined areas are meant to enclose the locations where each mouse was taken and do not depict the actual size or shape of the true home-range for each mouse.

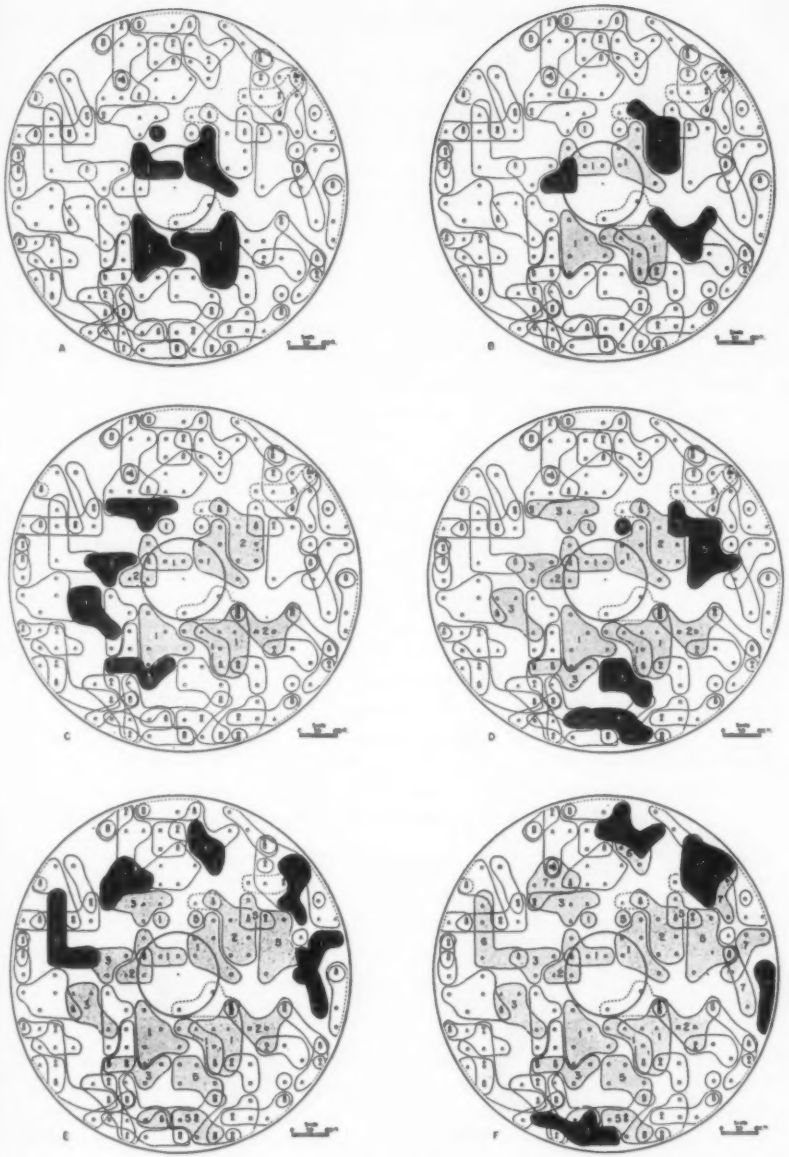

FIG. 1. A–F. Maps showing the source of adult male wood mice taken in a continuously snap-trapped 1-acre plot. The large circular plot is 17-acres in size; the smaller central plot is 1-acre. Movements of the mice in the 7-day live-trapping period are shown by enclosed areas. Animals taken in the central acre in snap-trapping are shaded in, with the night of capture indicated by numerals. Ranges enclosed with dotted lines are of animals that died during live-trapping.

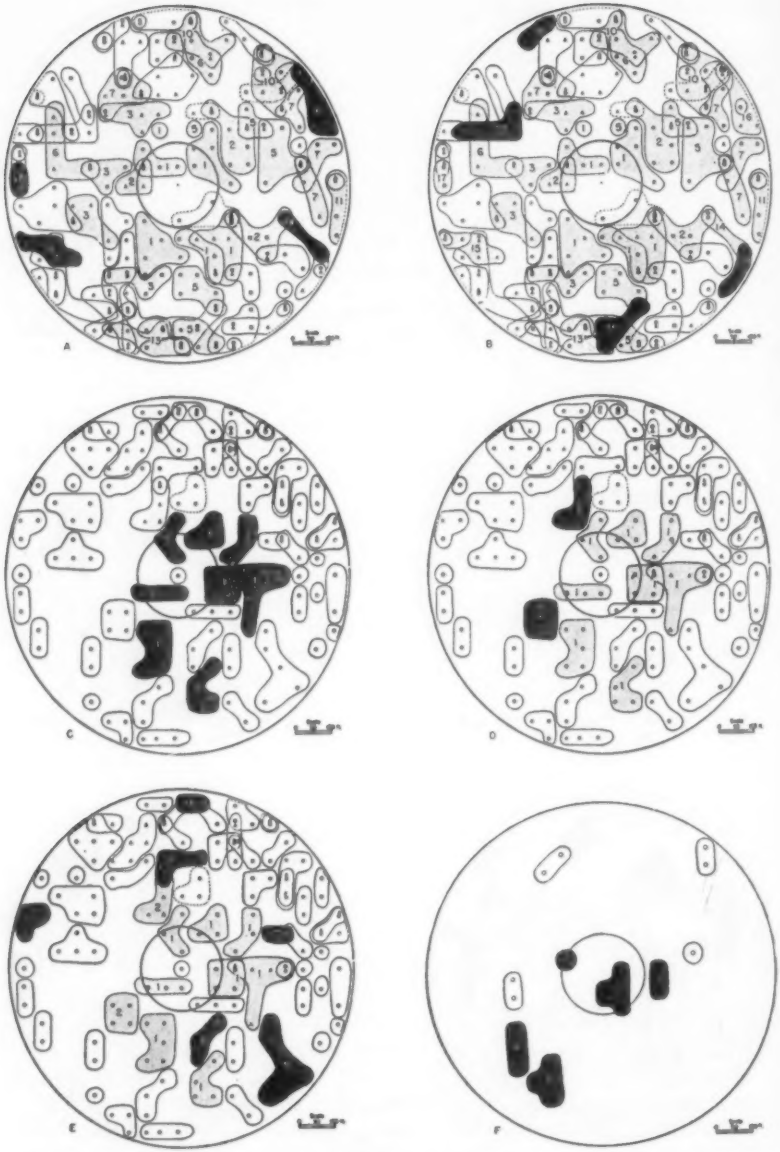

FIG. 2. Maps showing the source of wood mice taken in a continuously snap-trapped 1-acre plot. A–B: adult males; C–E: adult females; F: juveniles. The large circular plot is 17-acres in size; the smaller central plot 1-acre. Movements of the mice in the 7-day live-trapping period are shown by enclosed areas. Animals taken in the central acre in snap-trapping are shaded in, with the night of capture indicated by numerals. Ranges enclosed with dotted lines are of animals that died during live-trapping.

RESULTS OF SNAP-TRAPPING

The results of the snap-trapping are shown by the maps in Figures 1 and 2 and are presented in summary form in Table 1.

Study of the maps reveals that the animals whose normal ranges included or closely approached parts of the snap-trapped acre were the ones that were taken first. After these were removed from the area, the animals that were captured in the central acre were those whose normal ranges were farther away. With one or two exceptions, the more time that elapsed before a mouse was taken, the farther away from the central acre was its original range. In general the animals appeared to come in from all directions fairly regularly. On most nights the mice that were caught had had ranges that were in two or more different directions from the center; on a few nights the two or three animals taken seemed to have come from the same general direction. Direction of ingress appeared to have no correlation with wind direction.

After the third night of snap-trapping 13 males, 10 females, and 3 juveniles had been taken. By the 35th night of continuous trapping the numbers had increased to a total of 36 adult males and 18 adult females. All of these were marked animals previously taken during the 7 days of live-trapping. A total of 22 juveniles were also taken, of which 5 had been previously marked. Juveniles began coming out of their nests toward the latter part of the live-trapping period and it was to be expected that unmarked young would be taken in snap-traps as they left their nests.

After an interval of about a month the 200 snap-traps were replaced in the central acre for a 3-day period, November 18 to 20, and in this time 7 wood mice were taken, all juvenile unmarked animals.

Early the following spring, March 7 to 9, 1946, a similar 3-day snap-trapping period resulted in capture of five wood mice. All were unmarked, four of them young animals, presumably born the previous fall, one an adult male.

DISCUSSION

It is evident that most of the animals taken in the central plot had had established home areas before the snap-trapping began, that the majority were not vagrant animals. It is, of course, not known whether the animals retained their old home areas and were merely exploring out from them, whether they were trying to increase the size of their home areas, or whether they were actually changing their home sites.

The reason why the animals behaved as they did in this experiment cannot be positively stated, but it seems relatively certain that the continuous removal of wood mice from the acre-plot was the major incentive, for such extensive inward movement of neighboring animals is not found in live-trapping studies.

The movement of animals from all directions into the central acre in the present study is probably connected with the fact that the trapped plot was within an extensive area of similar habitat.

Adult males, adult females, and young juveniles all took part in the movement toward the depleted area, but the males outnumbered the females 2 to 1. The

number of juveniles taken was 22, slightly exceeding the number of females. The population was determined by live-trapping to consist of male and female adults in approximately equal numbers, so the excess of males obtained in snap-traps perhaps is due to their greater tendency to wander coupled with a normally more extensive range. Towsend (1935) provided data showing that in 14-day periods of snap-trapping, *Peromyscus* males were usually taken in far greater numbers than females. He believed that this effect was due to a greater wandering tendency in the males. The data from the present study supports his conclusion that sex-ratio figures should not be based on total snap-trap catch in a single area over an extended period. Burt (1940) and Blair (1940b) in live-trapping found a slightly higher percentage of males than females and likewise attributed the difference to a greater tendency to wander among males.

Several studies by other workers have demonstrated rapid invasion of depopulated areas, but in these examples the previous community status and home sites of invading animals were not known. Two of these studies may be mentioned here.

Blair (1940a) showed that a 5-acre area from which approximately 85 percent of the resident deer mice were removed was repopulated to about 50 percent of its former level within a two-week period and that there was little additional ingress in the two-week period following.

Spencer (1941) made a series of studies in range land near Tucson, Arizona, to obtain information on normal movements and drift of various small rodents. He "trapped-out" a 5-acre area with 150 traps and then determined numbers of invading animals by a 48-hour trapping period every two weeks from November to August. For the seven species considered in detail he found the least movement in March and April and the greatest in July and August. The individual species showed different drift rates. Some differences in periodicity were also shown. Since drift rate is presumably a function of population pressure and a seasonal fluctuation in population is known to exist (see especially Burt 1940 and Blair 1940a), the periodicity in extent of invasion found by Spencer was to be expected.

There are a number of reasons for believing that bait had a minor or neglibible influence in the present experiment. The fact that animals taken were those coming from succeedingly greater distances, closest neighboring animals in general being removed before more distant ones were taken, is evidence in this direction. Likewise the lack of correlation between wind-direction and direction of travel supports this belief. Bole (1939), as a result of experiments to determine if use of bait influenced rate of drift, found no differences in the yield of baited and unbaited snap-trap quadrats. In other Patuxent studies of this species, yields in traps from which bait was nearly or entirely absent due to action of rain or ants likewise tend to indicate a minimal effect when traps are set in saturation numbers. The magnitude and trend of the daily snap-trap catch seems to be normal when compared with results of others who have done snap-trapping in previously undisturbed areas. The trapping was carried on in the fall when natural food was abundant. In the live-trapping the daily catch to-

ward the latter part of the period did not exceed that of the first day, giving no evidence of bait addiction.

SUMMARY

1. The wood mouse (*Peromyscus leucopus*) population in a 17-acre area of bottomland forest was live-trapped, marked and released over a 7-night period. Following the live-trapping a central 1-acre plot was snap-trapped for 35 consecutive nights. All adult animals taken in the central snap-trapped plot had previously been taken, marked, and released in the live-trapped 17-acre area.

2. Animals taken first in the central acre were those whose normal ranges overlapped or closely approached this area. After these were removed from the area the animals captured in the central acre were in general those whose normal ranges were at succeedingly greater distances. Ingress was from all directions.

3. Most of the animals taken in the central area were those with previously established nearby home ranges, not merely vagrant animals.

4. Thirty-six of the invading animals were adult males, 18 were adult females, and 22 were young juveniles recently emerged from nests. Numbers of male and female adults had been shown in the live-trapping to be approximately equal.

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MAMMALS OF NORTHERN IDAHO

By Henry Judson Rust

Northern Idaho is an area of approximately 13,000,000 acres extending from Canada south to the Salmon River canyon, which crosses Idaho County from east to west. This natural barrier is considered as the dividing line or break between the Northern Rocky Mountain and the Central Rocky Mountain regions. With the exception of a little less than 3,000,000 acres which are open agricultural land, the region is extremely rough and heavily forested. The area at the extreme north is only 47 miles in width where it is bounded by British Columbia. On the east a succession of rugged mountain chains separate it from western Montana. On the west, from Canada south to Lewiston, Idaho, no natural barriers separate it from the state of Washington. From Lewiston, south, the Snake River forms a water barrier. The entire area was divided into four counties in 1884. These have been subdivided from time to time and now number ten.

Approximately 77 percent of the total area is forest land, of which 57.4 percent are National Forests, established in 1908. Other Federal lands comprise 2.4 percent; Idaho State Forest lands, 6.2 percent. The balance, 34 percent, is privately owned forest land. The National Forest lands are divided into seven National Forests, the size of each depending somewhat on such natural boundaries as water courses or mountain chains and their accessibility for proper management (fig. 1). The writer has spent considerable time over a number of years collecting and studying the flora and fauna of northern Idaho and offers part of the information thus obtained as an addition to that already known (see especially Davis, 1939).

Five of the seven primary life zones as formulated by Dr. C. Hart Merriam are present in northern Idaho, namely: (1) Upper Sonoran, which is represented by a small area in Nezperce County in the vicinity of Lewiston, Idaho, ranging in elevations from 750 feet to 1,800 feet. (2) Transition, at an approximate elevation of 1,800 feet to 3,200 feet, which contains practically all of the open ponderosa pine forest and agricultural land and reaches from the western boundary well into the foothills. This zone is well represented by a large number of characteristic plants, birds, and mammals. The flora of the Transition zone is the most extensive of the five and contains between 1,800 and 2,000 species of plants. This zone is divided into two divisions, the arid, covering the lowest and driest part containing the greater portion of the ponderosa pine, and the humid at the higher elevation containing most of the Douglas fir. Three different elements enter into the building up of the plant life in the Transition zone. These are the California species which have migrated from that state, the Columbian element which may have originated in the Columbia basin, and the Rocky Mountain species which are the dominant plants of the zone. (3) Canadian zone, which lies at elevations from 3,200 feet to 4,800 feet, covers a large area and is unique in that it contains the largest body of commercial western white pine on the continent. Here there is considerable overlapping of species of plants, birds and

mammals from the Transition below and the Hudsonian above, much more so than in any of the other zones. (4) Hudsonian zone, at elevations from 4,800 feet to 5,600 feet, is well represented with its characteristic species of trees, such

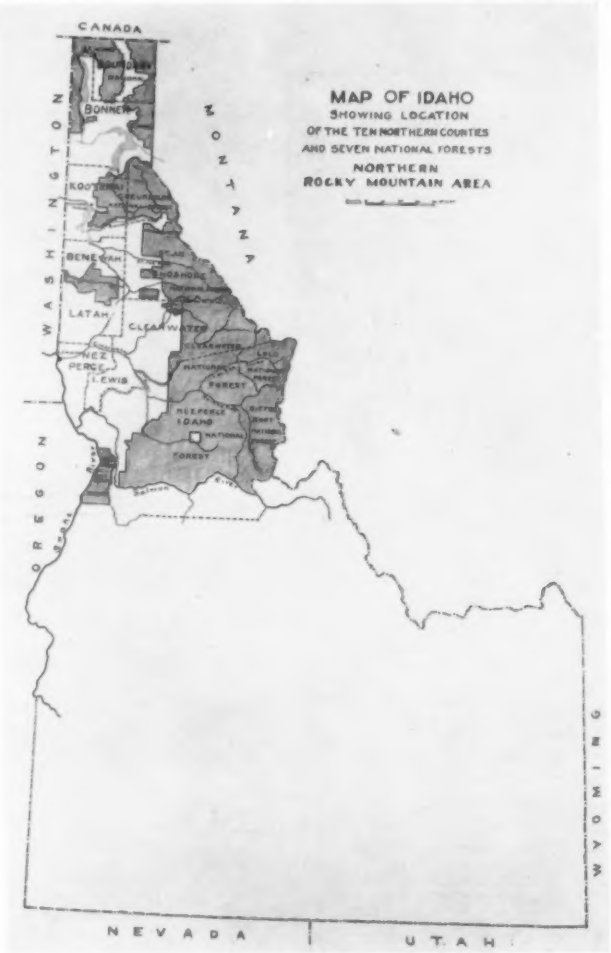

FIG. 1

as alpine fir, white-bark pine, alpine larch, and mountain hemlock, but with few breeding birds and mammals. (5) Arctic-Alpine zone, which reaches from timberline to the tops of the highest peaks at 7,200 feet and over. It is represented by but two species of breeding birds and very few mammals, but it has an in-

teresting and characteristic flora of which little information has been available for northern Idaho.

The writer wishes to express his sincere thanks to all those who have kindly given information and specimens, especially to the United States Forest Service officials of Region One, to numerous hunters and trappers, and to Dr. H. H. T.

The distribution of mammals in Northern Idaho by life zones

SPECIES	SONORAN	TRANSITION	CANADIAN	HUDSONIAN	ARCTIC-ALPINE
Sorex cinereus cinereus			X		
Sorex vagrans monticola		X	X	X	
Sorex obscurus obscurus		X	X	X	
Sorex palustris navigator		X	X	X	
Myotis lucifugus alascensis		X			
Myotis evotis chrysonotus		X	X		
Myotis volans interior		X	X	X	
Myotis c. californicus		X	X		
Eptesicus fuscus pallidus		X	X		
Lasiurus cinereus		X			
Ursus a. cinnamomum		X	X	X	
Ursus sp. (grizzly)			X	X	
Procyon lotor excelsus		X	X		
Martes caurina caurina			X	X	
Martes pennanti columbiana		X	X		
Mustela erminea invicta		X	X		
Mustela frenata nevadensis		X	X		
Mustela vison energumenos		X	X		
Gulo luscus luscus			X	X	
Lutra canadensis nexa		X	X		
Spilogale gracilis saxatilis		X	X	X	
Mephitis mephitis hudsonica		X			
Taxidea taxus taxus		X	X		
Vulpes fulva macroura		X	X	X	
Canis latrans lestes		X	X	X	
Canis lupus irremotus		X	X	X	
Felis concolor missoulensis		X	X	X	
Lynx canadensis canadensis		X	X	X	
Lynx rufus pallescens		X	X		
Marmota monax pretensis				X	
Marmota flaviventer avara		X	X		
Marmota caligata nivaria				X	
Citellus columbianus columbianus	X	X	X		
Citellus lateralis tescorum		X	X	X	
Eutamias amoenus amoenus			X	X	
Eutamias amoenus luteiventris		X	X		
Eutamias amoenus canicaudus		X	X		
Eutamias ruficaudus simulans		X	X		
Tamiasciurus h. streatori		X	X	X	
Tamiasciurus h. richardsoni		X	X	X	
Glaucomys sabrinus bangsi		X	X		
Glaucomys sabrinus latipes		X	X		

The distribution of mammals in Northern Idaho by life zones—Continued

SPECIES	SONORAN	TRANSITION	CANADIAN	HUDSONIAN	ARCTIC-ALPINE
Thomomys talpoides fuscus			x	x	
Thomomys talpoides saturatus	x	x	x		
Perognathus parvus lordi	x				
Castor canadensis pacificus		x	x		
Peromyscus maniculatus artemisiae	x	x	x		
Neotoma cinerea occidentalis		x	x	x	
Phenacomys intermedius intermedius			x	x	
Clethrionomys gapperi idahoensis		x	x		
Clethrionomys gapperi saturatus		x	x		
Microtus pennsylvanicus modestus		x	x		
Microtus pennsylvanicus drummondii		x	x		
Microtus montanus nanus			x	x	
Microtus longicaudus mordax		x	x	x	
Microtus richardsoni macropus			x	x	
Ondatra zibethica osoyoosensis		x			
Rattus norvegicus	x	x			
Mus musculus	x	x			
Zapus princeps kootenayensis		x	x		
Zapus princeps idahoensis			x	x	
Erethizon epixanthum epixanthum		x	x		
Ochotona princeps princeps			x	x	
Ochotona princeps cuppes			x	x	
Lepus townsendii townsendii		x			
Lepus americanus bairdii		x	x	x	
Sylvilagus nuttallii nuttallii	x	x			
Cervus canadensis nelsoni		x	x	x	
Odocoileus hemionus hemionus		x	x	x	
Odocoileus virginianus ochrourus		x	x		
Alces americanus shirasi			x	x	
Rangifer montanus		x	x		
Antilocapra americana americana		x			
Ovis canadensis canadensis			x	x	x
Oreamnos americanus missoulae			x	x	x

Jackson and Stanley G. Jewett of the U. S. Fish and Wildlife Service, the last two providing determinations of many of the small and scarce mammals.

ANNOTATED LIST OF MAMMALS

Sorex cinereus cinereus. Gray Shrew.—This small shrew is one of the most common of the four shrews known to occur in northern Idaho. From extensive trapping I found them most plentiful in the white pine stands in the Canadian zone on the Coeur d'Alene National Forest in Shoshone County and fairly common in the white pine areas 12 miles east of Weippe, Clearwater County. Specimens have also been recorded from Latah and Idaho counties. Near the Canadian boundary, the specimens of small shrews I secured were determined as *Sorex obscurus obscurus*, although the gray shrew should also be found there. This shrew is a great forager and can travel long distances under a layer of several inches of loose white pine needle duff very rapidly. Snails and ground inhabiting insects form part of its diet. It is also known to devour portions of the fleshy parts of small furbearers caught in traps. It

was invariably trapped in association with *Peromyscus m. artemisiae*, *Microtus l. mordax*, and *Eutamias r. simulans*.

Sorex vagrans monticola. Wandering Shrew.—This species has been collected in northern Idaho at elevations ranging from 2300′ to 6500′ and doubtless occurs at still higher elevations. Near Coeur d'Alene this shrew inhabits fairly open situations in the vicinity of swampy ground and grassy meadows. Its habits are very similar to those of the gray shrew. It has been collected and recorded in all but two of the ten northern Idaho counties.

Sorex obscurus obscurus. Dusky Shrew.—This shrew is more or less confined to the Canadian zone in northern Idaho. My only experience with it was on the Kaniksu National Forest near the Canadian boundary, where I caught it in traps placed along the sides of fallen logs. I found its habitat and habits similar to those of the gray shrew. The small mammal association was similar to that mentioned above for the gray shrew. Dusky shrews have been recorded from Boundary and Bonner counties.

Sorex palustris navigator. Water Shew.—I have no record of this species in Idaho farther north than Kootenai County where it is fairly common along many of the smaller tributaries of the Coeur d'Alene River drainage. It has also been recorded from Shoshone, Latah, and Idaho counties.

Myotis lucifigus alascensis. Little Brown Bat.—This bat is one of the two species of *Myotis* known to have been collected in northern Idaho, and it is the most common bat in the region. Individuals first appear in Kootenai County in early May. They usually leave their roosts about 5:00 p.m. and feed until dusk. In June they are often seen feeding in company with Pacific night hawks. They congregate in considerable numbers over the shores of lakes and streams because their type of food is most abundant in such locations. Specimens have been recorded from Kootenai and Latah counties.

Myotis evotis chrysonotus. Long-eared Bat.—One specimen was collected near Selway Falls, Idaho County, by the California Academy of Science expedition to the Clearwater Mountains September 8, 1941. This is the only record of occurrence for northern Idaho.

Myotis volans interior. Long-legged Bat.—This species is known in northern Idaho only from Kootenai and Idaho counties, whence six specimens have been recorded.

Myotis californicus californicus. California Little Brown Bat.—Eight specimens of this species were collected as they foraged over roads and water courses in the region of Selway Falls, Idaho County, in the fall of 1941 by the California Academy of Science expedition (see Orr, 1943).

Eptesicus fuscus pallidus. Big Brown Bat.—Next to *Myotis lucifugus*, the big brown bat is the most commonly observed species in the vicinity of Coeur d'Alene. The latest fall record is November 4.

Lasiurus cinereus. Hoary Bat.—On September 4, 1938, a specimen, found dead on a lawn in Coeur d'Alene, was presented to the writer. It was made into a study skin and given to the U. S. National Museum.

Ursus americanus cinnamomum. Black Bear.—The black bear is well distributed over much of the timbered area of northern Idaho. The study of the yearly estimates of big game on the National Forests of northern Idaho, Region One, from 1921 to 1942 inclusive, reveals 4.5 bears per township. In 6 years (1927) the estimate was nearly double, but in the next 13 years the trend was downward. In 1941 there was a decided increase, which was exceeded in 1942, with an average of 10 bears per township.

There are a number of annual records of bear kills during the open season in northern Idaho, but none that I have seen pertaining to the numerical ratio of the black and brown color phases. I have kept a record for a number of years of both live and dead bears I have seen from the Canadian boundary south to the Salmon River, covering 8 of the 10 counties. The number to date (1946) totals 131, of which 90 are black and 41 brown—a ratio of a little over two blacks to one brown. Among the number recorded are 19 females with cubs. Eight of them had one cub each; nine, had two cubs; two, three cubs. Each of two black females was with one overwintering black cub. Color phase of cubs, 21 black and 11 brown—near two to one. Color phase of females, 14 black and 5 brown—near three to one.

Prior to the creation of the National Forests in northern Idaho in 1908, the black bear was seldom seen outside of densely forested areas. With the construction of trails, roads, and ranger stations, followed by numerous logging camps and commercial huckleberry picking, however, the bear began to acquire a taste for the white man's diet, as has been noted in national parks and elsewhere. With the advent of sheep grazing on the forests, the bear acquired a bad reputation as a sheep killer. During 1923 a number of bears began to roam outside the forests in some of the northern counties and soon became quite a nuisance by destroying fruit bearing orchard trees, robbing apiaries, rabbit hutches, and finally pig pens. There was no closed season on these animals in northern Idaho until some years later so many of them were shot or trapped when and wherever seen. There is now a closed season of 9 months.

About the latter part of October, depending on weather conditions, the black bears begin to prepare dens for hibernation and are generally under cover by the middle of November. Hibernation dates that I have vary from November 14 to 26. Uprooted trees are a favorite location, the den being dug out at the base of the tree and limbs or other available material piled around the opening which is later covered with deep snow. The majority of the dens are in the upper Canadian zone. Severity of the weather and depth of the snow govern the departure from the den in the spring. Males usually emerge from two to three weeks before females with small cubs. In event the travelling is too difficult for the young cubs the mother bear often returns to the den until conditions improve.

The cubs are born in the den usually from the latter part of January to the first week in March. I have a recent record from Shoshone County of two cubs, each weighing 16 ounces, taken from a den on February 18. The mother bear was brown as were the cubs, which were raised by hand. Occasionally a yearling cub will den with its mother and travel with her the second spring. This may be a case of the female failing to mate and caring for her cub the second winter. Two such instances were noted in the 19 females with cubs reported above. The overwintering cubs are so large that there is no mistaking them.

Bears depend mostly on their immediate surroundings for a food supply. In the spring they feed on wild sweet clover, bulbs of the spring beauty, camas, and yellow lillies, roots of skunk cabbage, wild onions, and carrion of animals that died during the winter. In summer, insects form a considerable part of their food. These consist of several species of formica ants that construct large mound-like nests and large black carpenter ants which are secured from decaying stumps and logs; also various beetles and grubs found by overturning flat rocks. Later in the summer they feast on ripening wild fruit, especially huckleberries which grow in great profusion on the higher slopes and mountain tops. Since these berry patches are now annually invaded by commercial pickers, the bears loose a considerable supply of their favorite food. Perhaps this is why some of them in turn invade the various orchards at the lower elevations near the forest boundaries.

Since large cold storage plants are now available, considerable bear meat is stored for overwinter use. The hides when taken late in the season have a fair value as fur, selling from $15 to $20 or more.

Ursus sp. Grizzly Bear.—Unfortunately the status of the grizzly bear in northern Idaho has reached the stage where its specific identity may never be solved. In fact, this may be true throughout the northwestern states. The Region One U. S. Forest Service estimate of big game for 1941 in northern Idaho lists only 25 grizzlies on the seven forests, 5 each in the Bitterroot, Kaniksu, and St. Joe; 10 in the Lolo, and 0 in the others. The 1942 estimate for the adjoining forests in northwestern Montana were: Flathead 170, Kootenai 70, Cabinet 5. These forests offer a much greater area of wilderness which is more to the liking of the grizzly bear.

Procyon lotor (excelsus?). Raccoon.—Previously raccoons have not been recorded from farther north in Idaho than the Clearwater drainage in Idaho County. While trapping for fur, I saw specimens of raccoon trapped along the Little Spokane River, Spokane County, Washington 15 miles west of the Idaho state line in 1901, and numerous tracks in what is now Pend Oreille County, Washington, in 1902. There were then no records for northern Idaho.

The first record I have for Kootenai County is of a large male raccoon killed in September 1919 in an alder swamp three miles east of Coeur d'Alene. I saw this specimen when it was freshly mounted in a local taxidermy shop, but I did not take any measurements. The general size and coloration corresponded very closely to the description of *P. l. excelsus*. A state game warden residing at Kellogg, Idaho, recently advised me that a raccoon was trapped on the southeast portion of the Coeur d'Alene National Forest in the fall of 1944, and that they occurred sparingly along the St. Joe River in Shoshone County. One was seen on Marble Creek, and one was trapped on Foehl Creek, both on the St. Joe National Forest, one in 1919, the other in 1921. In November 1944 a large raccoon was trapped by a state trapper on the south shore of Lake Coeur d'Alene 1½ miles from the town of Coeur d'Alene. In early March 1945, a raccoon was taken at a poison bait set for coyotes a few miles west of Spirit Lake at the extreme northern boundary of Kootenai County. I was unsuccessful in securing the skulls of either of the two last mentioned specimens. Raccoons have also been recently reported from Rock Creek near Worley, not far from the Benewah County line. These records suggest that the raccoon has moved north along the upper Clearwater River drainages to the St. Joe River drainages and on to swampy areas in Kootenai County. Raccoons are on the trapping list for Clearwater and Nezperce counties during an open season from Nov. 1 to Feb. 28.

Martes caurina caurina. Marten.—In northern Idaho this animal occurs from the Canadian boundary south through the heavily wooded areas to the Salmon River in Idaho County, in the Canadian and Hudsonian zones. My use of the specific name (*caurina*) for northern Idaho martens is based on the determination of five adult skulls from Shoshone and Kootenai counties by Dr. H. H. T. Jackson.

Martens have been very heavily trapped in northern Idaho from the time of the early fur traders to within the past few years when trapping of this furbearer was prohibited in some areas. They still are present over much of their former range but in moderate numbers. The Region One Forest Service annual wild life report for 1941 estimates the marten population for northern Idaho as follows: Bitterroot, 850; Clearwater, 750; Coeur d'Alene, 200; Kaniksu, 500; Lolo, 600: Nezperce, 1400; St. Joe, 2000. The heavy drain on the coyote and bobcat populations by predator control may be having some influence on the present increasing number of marten by providing more subsistence in the way of the smaller mammals.

Martes pennanti columbiana. Fisher.—The fisher is restricted to the wooded, mountainous portions of the northernmost counties and, so far as known, has always been a rare animal throughout its general range in the United States. During my long residence, I know of only two records in Kootenai County. An adult fisher was killed on the south shore of Coeur d'Alene Lake in the fall of 1893 by a soldier stationed at Fort Sherman, now part of the city of Coeur d'Alene. A more recent record is the trapping of an adult fisher by a licensed trapper at the junction of Haystack and Big creeks on the Coeur d'Alene National Forest, Shoshone County, in the fall of 1916. The pelt was seen by a dozen or more people. There are numerous reports of their tracks being seen in the snow on several of the forests but none of these can be verified by specimens.

Mustela erminea invicta. Short-tailed Weasel.—The present known range of this weasel in northern Idaho is from Bonner County south to the Lochsa River, Idaho County. The short-tailed weasel, although fairly common throughout its range in northern Idaho, is less abundant than the long-tailed species.

Mustela frenata nevadensis. Long-tailed Weasel.—The long-tailed weasel is well distributed in the timbered areas of northern Idaho. It ranges vertically from the lower border of the Transition at 2200 feet to the Hudsonian zone at 4800–5600 feet. A large number of long-tailed weasel are trapped annually. The present price of $1.50 per skin makes it quite profitable for the trappers.

Mustela vison energumenos. Mink.—My use of the name *energumenos* is based on the determination of five adult mink skulls from Kootenai and Shoshone counties by Dr. H. H. T. Jackson. These skulls are now numbers 274541–274545, U. S. Biological Surveys collections. The mink is still fairly well distributed along the larger mountain streams and remote lakes in the timbered areas of northern Idaho. The Region One U. S. Forest Service annual report

of game and furbearer for 1941 estimates the number of mink as follows: Bitterroot, 950; Clearwater, 650; Coeur d'Alene, 280; Kaniksu, 470; Lolo, 250; Nezperce, 1800; St. Joe, 300. The estimated take for 1941 by 120 trappers was 520.

Gulo luscus luscus. Wolverine.—Formerly occurred in moderate numbers in inaccessible mountainous regions in the central portions of the state. Very little is known of its occurrence in northern Idaho. I have the record of one from the Coeur d'Alene National Forest in Kootenai County. In the latter part of August 1930, a wolverine was seen at close range on South Chilco Mountain by an old experienced trapper who worked as a forest service lookout during the summer months and by a huckleberry picker who was near the lookout at the time. Tracks of a wolverine were seen on a nearby drainage during the winter of 1930–31. Another trapper reported seeing a wolverine occasionally over a period of six years, 1931–37, in nearby areas, where it followed his trapline. Three wolverines were trapped on Norton Creek, a tributary of Marble Creek, 10 miles northeast of Clarkia, Shoshone County, in the winter of 1908.

Lutra canadensis nexa. Otter.—Twenty years ago the otter was fairly common along many of the larger streams and isolated lakes of the ten northern counties. It is now much reduced in numbers owing to excessive trapping and present lack of seclusion. It is most common on the Selway River drainage.

The Pacific coast race, *Lutra canadensis pacifica*, has been collected in the state of Washington within 65 miles of the western boundary of Kootanei County, Idaho. However, skulls of two adult otters from a group of seven taken by a licensed trapper in Shoshone County in 1923 were examined by Dr. H. H. T. Jackson who advised me that he was surprised to find these specimens not separable from *nexa*, having all the skull characteristics of that subspecies. Specimens from south central Idaho have also been determined as *nexa* so it is quite probable that this otter has been following up the Selway and Clearwater River drainages and crossing over into Shoshone county by way of the Clearwater and St. Joe divide. The otter is a great traveller and will often follow up a stream to its head in the higher elevations, cross over a dividing ridge and down a stream on the opposite side and into a new drainage. In areas where little molested during the summer months, their slides can be found, indicating their presence and probable breeding.

Trapping of otter in District One of the northern counties is prohibited at present. The annual wildlife report of Region One U. S. Forest Service for 1941 estimates the number of otter for northern Idaho as follows: Bitterroot, 65; Clearwater, 95; Coeur d'Alene, 0; Kaniksu, 0; Lolo, 35; Nezperce, 130; St. Joe, 25. A total of 15 was taken by trappers in 1941.

Spilogale gracilis saxatilis. Western Spotted Skunk.—For northern Idaho there are two records of occurrence. In the fall of 1941, the California Academy of Science expedition trapped a specimen 4 miles southeast of Selway Falls at an elevation of 5800′ in Idaho County. This locality was estimated to be 160 miles north of any previous record of the species in Idaho. In March 1945 an old time trapper and summer employee of the U. S. Forest Service advised me that he had trapped two spotted skunks on his premises at St. Maries, Benewah County, during the winter of 1944–45. I was unable to secure either the skins or skulls as they had been destroyed. This skunk was recorded from Almota and Kamiak Butte in Whitman County, Washington, as early as 1929, specimens being in the Charles R. Conner museum at Pullman, Washington. Almota is but 20 miles west from Moscow, Latah County, Idaho, and 62 miles southwest of St. Maries, Idaho. This species is possibly moving into northern Idaho through the open grain belt area along the Idaho-Washington boundary and may eventually be recorded much farther north than now reported.

Mephitis mephitis hudsonica. Striped Skunk.—This skunk formerly was abundant in northern Idaho, particularly in the open ponderosa pine belt in what is now Latah, Benewah, Kootenai and Bonner counties. Their dens could be readily found in cavities under large boulders, at the base of windfalls, old log piles, abandoned as well as occupied buildings, and occasionally in open railroad culverts. As the country became more densely settled, many of the skunks were shot, trapped, and poisoned, and by 1920 they were beginning to disappear rapidly. Intensive ground squirrel poisoning campaigns as well as poisoned bait trap lines

no doubt eliminated many of the skunks in a few years. Since 1940 they have shown a slight increase in Kootenai County and are occasionally seen on the well travelled highways. The Region One U. S. Forest Service annual report of game and furbearers for northern Idaho for 1941 estimates the number of skunks as follows: Bitterroot, 75; Clearwater, 35; Coeur d'Alene, 80; Kaniksu, 1000; Lolo, 100; Nezperce, 500; St. Joe, 1100. The estimated number taken by trappers in 1941 was 200.

Taxidea taxus taxus. Badger.—The badger, while fairly well distributed over northern Idaho, is more commonly seen and recorded from the open wooded situations in the Transition zone than in the heavily timbered portions of the Canadian zone where it also occurs. This can be correlated with the distribution of the columbian ground squirrel which forms the bulk of the badger's food supply. The badger is more frequently noted around the ground squirrel colonies in late summer and early fall when the squirrels are well along in hibernation. The region One U. S. Forest Service annual report of game and furbearers for northern Idaho for 1941 estimates the badger pppulation as follows: Bitterroot, 500; Clearwater, 200; Coeur d'Alene, 170; Kaniksu, 470; Lolo, 200; Nezperce, 420; St. Joe, 640. The estimated trapper take for 1941 was 80. Many more are probably destroyed by poison baits used by predator control agents.

Vulpes fulva macroura. Red Fox.—The red fox occurs sparingly throughout the heavily timbered mountainous areas of northern Idaho in the Canadian and Hudsonian zones, breeding in rocky outcrops on the high ridges and peaks. Measurements of an adult male trapped on a high ridge on the Coeur d'Alene National Forest in Kootenai County are: total length, 1225 mm; tail, 413; hind foot, 152. The skull is now number 274551, U. S. National Museum. The Region One U. S. Forest Service annual report on game and furbearers for northern Idaho for 1941 estimates the red fox population as follows: Bitterroot, 280; Clearwater, 130; Coeur d'Alene, 80; Kaniksu, 30; Lolo, 30; Nezperce, 370; St. Joe, 170. Legal trapping for fox in District One northern Idaho was stopped for some time, but it was again permitted in 1945, the open season lasting from Sept. 1, to Jan. 31. Cross foxes are occasionally seen on the St. Joe National Forest, Shoshone County.

Canis latrans lestes. Coyote.—The coyote has been an abundant resident of the entire area included in northern Idaho as far back as records of the furtrappers and traders go. The Region One U. S. Forest Service annual report on game and furbearers for northern Idaho for 1941 estimates the number of coyotes as follows: Bitterroot, 930; Clearwater, 1200; Coeur d'Alene, 820; Kaniksu, 1300; Lolo, 250; Nezperce, 3400; St. Joe, 900. The estimated number killed in 1941 on or near national forests by the Fish and Wildlife Service was 1300; by forest officers, 25; by others, 820, making a total of 2145.

Canis lupus irremotus. Gray Wolf.—The wolf as a resident of northern Idaho is without doubt an animal of the past. There is still a possibility that one may occasionally wander across the boundary from Canada, but none has been reported for a long time. The last specimen that I saw was one killed near Coeur d'Alene in 1905. It was mounted entire, exhibited for a short time, and then taken to some other locality. The Region One U. S. Forest Service annual report on wild game for 1941 lists 25 wolves for the entire forested area of western Montana, and none for northern Idaho.

Felis concolor missoulensis. Puma.—Formerly quite numerous in what is now Boundary, Bonner, Kootenai, Shoshone, Clearwater, and Idaho counties, particularly in wooded areas which afforded plenty of cover for them as well for the larger game mammals on which they depended for food. With the establishment of the federal and state predatory control agencies, and the greatly increased bounty, formerly $15.00, later $30.00 and now raised to $50.00 per scalp, they are gradually being eliminated over much of their former range in northern Idaho. Their chances of escape in winter when they leave trails in the snow are slight, and it is at this time they most often are pursued by trained dogs.

Of fourteen records that I have of females with young, the number of kittens varied from one to four as follows: two females with one young; four with two; three with three; and five with four. Breeding dates for the four most northerly counties are: Jan. 15, 1924.—3 kittens estimated at less than one month old, date or birth approximately December 20. Jan. 30,

1933.—4 kittens estimated to be 10 days old. March 12, 1941.—3 kittens estimated to be 14 days old. From the first week in December to the middle of March is the usual breeding period.

Of 24 adults examined by me, 14 were females, 10 were males. Probably no other mammal in the northwestern states is subject to such reported variations in size. This is no doubt due to pacing the length or to measurements made of freshly removed skins which are capable of being stretched. This accounts for the numerous kills reported to measure up to ten and eleven feet. Of 21 records from northern Idaho, twelve females (with a range from 6 feet, 9 inches to 7 feet, 6½ inches) averaged 7 feet, 1 inch in total length. Nine males (with a range of 7 feet, 3 inches to 8 feet, 1 inch) averaged 7 feet 8 inches total length, with the tail varying from 24 to 31 inches. Five adult females averaged 146 pounds; average of eight males, 182¼ pounds.

Whitetail and mule deer, with an occasional elk, supply the greater portion of their winter food. Old animals with badly worn teeth and lack of speed in the chase frequently leave the wooded areas and prowl around ranches and kill domestic stock. Their diet during the summer months is apparently not fully known. Mountain sheep and goats, as well as smaller mammals such as snowshoe hares and an occasional porcupine help supply their summer diet. Much speculation is advanced as to the number of deer killed annually by a full grown mountain lion. Because there is little chance to check during summer months, most estimates are based on winter reports, usually by those who make a business of hunting them. Often these hunts last for days, especially in rough country, and when hungry and being steadily followed by dogs a lion will kill at each chance, often leaving the kill without feeding on it. As many as eight deer killed in three days have been recorded on these long hunts. When deer are forced to yard up during deep snow, excessive killing by mountain lions is usually the case. Their ordinary annual kill probably falls within a range of 40 to 60 deer.

Lynx canadensis canadensis.—Canadian Lynx.—While nowhere abundant in northern Idaho, the Canadian lynx is fairly well distributed throughout the wooded areas of 8 of the 10 northern counties, largely in the Canadian and Hudsonian zones. The Region One U. S. Forest Service game and furbearer report for 1941 estimates the lynx population for northern Idaho as follows: Bitterroot, 130; Clearwater, 30; Coeur d'Alene, 60; Kaniksu, 65; Lolo, 5; Nezperce, 220; St. Joe, 90. Twenty-five or 30 lynxes are usually trapped or shot annually by local trappers and hunters in addition to those secured by the state and federal predator control agents. Not as prolific a breeder as the bobcat, it is possible that in a few more years the lynx will be well on the way to extermination in northern Idaho.

Lynx rufus pallescens. Bobcat.—Although destroyed in large numbers yearly by state and federal trappers and hunters, the bobcat is still fairly common and widely distributed over most of the wooded areas of northern Idaho. The Region One U. S. Forest Service annual report on game and furbearers for 1941 estimates the number of bobcats for northern Idaho as follows: Bitterroot, 220; Clearwater, 65; Coeur d'Alene, 40; Kaniksu, 120; Lolo, 5; Nezperce, 510; St. Joe, 240. They are found most frequently in the Canadian zone, but during severe winters many of them, particularly the younger cats, migrate to lower elevations in the Transition zone among the outlying settlements and at times into thickly populated areas in search of food.

Marmota monax petrensis. Woodchuck.—This species is believed to occur sparingly throughout the timbered areas of the northern Rocky Mountains in western Montana and northern Idaho. Only one specimen is known from Idaho, which was collected at Thompson Pass, Shoshone County. This pass is in the Bitterroot Mountains between Thompson Falls, Montana, and Murray, Idaho.

Marmota flaviventris avara. Yellow-bellied Marmot.—This species occurs in moderate numbers in Kootenai, Benewah, Shoshone, and Idaho counties, and possibly in some areas between the last two counties. Much of the population is of recent occurrence, having migrated from the states of Washington and Montana. Several years ago Howell (1915) recorded a small colony of marmots at Spokane Bridge, Washington. This locality is a few miles west of Post Falls, Kootenai County, Idaho. The Idaho-Washington boundary line

passes within one-fourth mile of the site. I examined the colony and adjacent areas in Idaho a number of times in the period 1924–34. The colony was located on a low rocky hill and was scattered over some 80 acres. In 1930 small gardens were being planted on a part of the area and an extensive poisoning campaign was in progress, which soon thinned the marmot population. I had been expecting for several years to find some evidence of extension of range into Idaho and in 1934 I found that they were becoming established in a desirable habitat under large loose boulders a short distance west of Post Falls. On February 2, 1935, two half-grown yellow-bellied marmots were captured along the rocky shore of Lake Coeur d'Alene 14 miles southeast of the Spokane Bridge area. They were taken to Coeur d'Alene and exhibited on a street corner, attracting considerable attention. This species was also present in moderate numbers 17 miles north of Prichard, Shoshone County, in 1932. It has also been recorded from near St. Maries, Benewah County, and from Idaho County.

Marmota caligata nivaria. Hoary Marmot.—Hoary marmots are fairly well distributed on the south exposures of numerous mountain peaks ranging from 6,200 to 6,800 feet elevation on the St. Joe National Forest, Shoshone County, Idaho. Occasionally they are seen at lower levels. They are often seen in association with the pika and the red fox. I examined one adult specimen taken on the St. Maries River drainage near Clarkia, Idaho. Orr (1943) reported this species from the lower drainages of the Clearwater River, Idaho County, and Howell (1915) records their occurrence on the headwaters of the Clearwater River.

Citellus columbianus columbianus. Columbian Ground Squirrel.—This species was formerly mostly a resident of the lower elevations in the Transition zone, but of recent years it has been following up the more open sunny slopes and ridges and extending its range well into the Canadian zone and even to the border of the Hudsonian zone at elevations from 4,500 to 6,500 feet. Prior to well established settlements in northern Idaho, the Columbian ground squirrel was partly held in check by the many raptores and coyotes which were also present at that time. With the almost total extermination of many of the hawks and the greatly reduced number of predatory animals, the farming communities have had to resort to the use of poison to hold the squirrel populations in check.

The time of the spring emergence depends on the exposure, weather conditions, and the amount of frost in the ground. The earliest record I have is January 16, 1932, on open prairie land in Kootenai County, with no frost in the ground. From the second to the last week of March is the usual time of emergence at lower levels. At higher elevations, emergence often is delayed until early May. The feeding period averages approximately 130 days, from March 20 to August 1. The latest feeding date available in Kootenai County is August 15, 1944.

Citellus lateralis tescorum. Mantled Ground Squirrel.—These squirrels range widely in northern Idaho. I have seen them in Kootenai and Shoshone counties from the lower stream levels in the Transition zone to the higher open ridges and rock outcroppings in the Hudsonian zone where they appear to be most numerous. There are records from Bonner, Kootenai and Shoshone counties in northern Idaho.

Eutamias amoenus amoenus. Klamath Chipmunk.—This chipmunk is known to occur in northern Idaho only in the vicinity of Riggins, Idaho County. It prefers open forest and rocky and bushy areas along the edge of the forest.

Eutamias amoenus luteiventris. Klamath Chipmunk.—This chipmunk has a preference for the more heavily forested areas and in northern Idaho it has been collected in Boundary, Bonner, Lewis, and Idaho counties with a big hiatus between the most northerly and southerly localities where known.

Eutamias amoenus canicaudus. Klamath Chipmunk.—This chipmunk inhabits the open forests, mainly in the Transition zone, with a preference for rocky and brushy areas. It has been recorded from Bonner, Kootenai, Shoshone, Latah, and Clearwater counties.

Eutamias ruficaudus simulans. Red-tailed Chipmunk.—This chipmunk is probably the most plentiful and widely distributed of the four kinds of *Eutamias* found in northern Idaho. I have personally collected this species from near the Canadian boundary south to 12 miles east of Weippe, Clearwater County, and it has been found quite plentiful in Idaho County, which may be its southern limit in the state. In the most northern counties, this

chipmunk can invariably be found in sunny openings in the ponderosa pine belt in the Transition zone where boulders and low brush are present, particularly along old roadways and at the lower edge of foothills. In the forests in the Canadian zone they can usually be found around fallen logs and brush piles.

On June 15, 1920, I noticed a grass-like nest fastened in a crotch of a bush along the shore of a small lake and landed to investigate. The nest was made of dry grass blades, oval in shape, measured 7 by 10 inches in outside dimensions, and had a small entrance opening at one end. I opened up the mass and was surprised to find four young chipmunks about one-third grown, quite well furred, but with their eyes still unopened. I photographed the young in the nest and replaced it as near as possible to its original shape and location. The usual nesting site for this species in the Transition zone is in crevices in large boulders or under old log piles.

Tamiasciurus hudsonicus streatori. Red Squirrel.—Formally abundant throughout all the timbered areas of northern Idaho, ranging from the Transition zone into the Hudsonian zone. Now much less plentiful and restricted largely to the Canadian zone.

The home range of this species varies in size from 1 to 10 acres, depending somewhat on the available food supply. The size and length of time an area has been in use can be judged partly by the amount and depth of the middens. Nests are either constructed of dried grass and lichens and placed at heights varying from 15 to 40 feet in coniferous trees, or old flicker or woodpecker nesting cavities in partly decayed stubs are used. Nesting cavities are more often used by females with young.

Seeds from all the species of conifers growing in the habitat are used for food. The cones are cut loose and fall to the ground. This is done shortly before the natural seed dispersal period and the cones are stored in various places as a constant food supply for the winter. The cones are cut from the grand fir first because when ripe the scales separate from the core, which remains on the tree, and the seeds are dispersed by the wind. By securing the cones before they begin to shed and storing them in wet places they remain intact until opened by the squirrels. Various species of fungi are gathered when they first appear. Some are eaten while fresh while others are placed in crotches of the larger shrubs and left to dry for future use. Young birds are occasionally included in the squirrel's diet, but I have noticed very few instances of this kind. Wild fruits are also eaten in season.

Specimens of *streatori* are available from Bonner, Boundary, Benewah, Clearwater, northeastern Idaho, Keotenai, Latah, Lewis, and Shoshone counties.

Tamiasciurus hudsonicus richardsonii. Red Squirrel.—This race reaches northern Idaho only in Idaho County where it intergrades with *T. h. streatori*.

Glaucomys sabrinus bangsi. Northern Flying Squirrel.—This species is known in northern Idaho only from Idaho County, the greater portion of its range lying farther south in the state. These flying squirrels inhabit the more dense portions of the forest in the Canadian and Hudsonian zones and, being nocturnal in habit, are seldom seen. Many of them are caught annually in traps set for the smaller furbearers.

Glaucomys sabrinus latipes. Northern Flying Squirrel.—The range of this race is known to extend from the Canadian boundary south to Idaho County. I have found it to be fairly common in the Transition and Canadian zones in Kootenai County. They use grass nests as well as old abandoned flicker or woodpecker nesting cavities in decaying stubs. In stands of young reproduction of larch or ponderosa pine where the grass nests are more commonly found, the female constructs one for herself and young and the male maintains his own apartment a short distance away. The nests are constructed of dry grass blades and lined with lichens and fastened to the bole of the tree and to a supporting limb at heights varying from 12 to 15 feet. The adult squirrels are loath to leave their nests during the day time. The young are born early in June. Nests that I have examined in mid-June contained young about one-third grown with their eyes still unopened. One to three young, with two being the most common, were found in the grass nests investigated. Three young were found to be most common in cavities in stubs.

Thomomys talpoides fuscus. Brown Pocket Gopher.—Of the ten known kinds of pocket gophers that occur within the present boundaries of the state of Idaho, only two have been

recorded from northern Idaho. One of these (*fuscus*) commonly inhabits the meadows and grassy wooded parks in the Canadian and Hudsonian zones. Most of this area is in unsettled country, hence little harm is caused by the extensive tunneling of the gophers near the surface of the ground. The race *fuscus* has been recorded in northern Idaho from Bonner, Kootenai, Latah, Nezperce, and Idaho counties and may occur in the others.

Thomomys talpoides saturatus. Brown Pocket Gopher.—This race is common in the Transition zone, especially in the agricultural sections where it causes considerable damage in gardens and cultivated fields by its feeding and tunneling activities. It is known to occur from the Canadian boundary south to the Selway River drainage in Idaho County.

Perognathus parvus lordi. Northwest Pocket Mouse.—In northern Idaho this pocket mouse is known only from Lewiston, Nezperce County, but it has been recorded from Spokane Bridge, Washington, which is one-fourth mile from the Idaho state line. It is quite possible that these mice also occur on the Idaho side of the line in Kootenai County.

Castor canadensis pacificus. Beaver.—The determination of the beaver in northern Idaho as *C. c. pacificus* Rhoades was made by Dr. H. H. T. Jackson, based on the examination of eight skulls from Bonner, Kootenai, and Shoshone counties presented to the U. S. National Museum by the writer. Beavers are well distributed over northern Idaho. At one time they were plentiful on all of the larger streams, but they are now scarce in a large portion of their former area and almost exterminated in some localities. The largest of 20 beavers caught in the Clark Fork area in 1945 weighed 57 pounds. Many old mature beaver trapped late in the fall or winter in Bonner, Kootenai, and Shoshone counties in northern Idaho weigh from 60 to 80 pounds, a few exceeding that weight. In 1941 the Region One U. S. Forest Service game and furbearer census estimated the number of beaver in northern Idaho as follows: Bitterroot, 660; Clearwater, 100; Coeur d'Alene, 1600; Kaniksu, 1600; Lolo, 240; Nezperce, 1400; St. Joe, 500. Since 1939 between 4,000 and 5,000 beavers have been trapped alive on streams in northern Idaho and transplanted to the southern part of the state. Many of them are also pelted.

Peromyscus maniculatus artemisiae. White-footed Mouse.—This mouse is one of the most common and widely distributed of the smaller mammals in northern Idaho, being most abundant in the Transition and Canadian zones. It has been collected in all counties in the area under consideration.

Two live females of this species, trapped by the writer on June 6, 1929, in Shoshone County, were liberated in a cage in which a couple of inches of duff and two pieces of bark 4 by 6 inches had been placed. At first they began to quarrel, but on examining the cage 1½ hours later neither mouse was in sight. Lifting up one of the pieces of bark I was surprised to find both females trying to cover five newly born young in a shallow nest formed in the duff. It was crowded, but both females apparently mothered the young until the nest became so crowded that one of them finally took shelter under the other piece of bark.

Neotoma cinerea occidentalis. Bushy-tailed Woodrat.—This rat is common in the wooded areas of the Transition, Canadian and occasionally the Hudsonian zones in northern Idaho. It occurs from the Canadian boundary south to the Salmon River, Idaho County. Recorded from Bonner, Idaho, and Latah counties.

Phenacomys intermedius intermedius. Rocky Mountain Phenacomys.—Although occasionally found in the upper portion of the Canadian zone in suitable locations, these small voles inhabit open grassy parks mainly in the Hudsonian zone. They are one of the scarcer small mammals inhabiting northern Idaho. Less than a dozen specimens have been collected to date in Bonner, Shoshone, and Latah counties.

Clethrionomys gapperi idahoensis. Red-backed Mouse.—Specimens that I have trapped near Weippe were taken in locations similar to those occupied by *Clethrionomys gapperi saturatus* farther north. In northern Idaho, this race occurs at higher elevations in the Canadian Zone in Clearwater and Idaho counties.

Clethrionomys gapperi saturatus. Red-backed Mouse.—This mouse is fairly well distributed throughout the forested areas of the Transition and Canadian zones. I have trapped them in Kootenai and Shoshone counties along-side fallen logs in association with *Peromyscus m. artemisiae, Microtus l. mordax, Sorex c. cinereus*, and *Eutamias r. simulans*.

Microtus pennsylvanicus modestus. Pennsylvania Meadow Mouse.—This mouse occurs in the marshy meadows and damp grassy places along creeks and lake shores in the Transition zone. The only record of its occurrence in northern Idaho is from the vicinity of Coeur d'Alene, Kootenai County.

Microtus pennsylvanicus drummondii. Pennsylvania Meadow Mouse.—This northern race occurs in the extreme northern portion of the state. Specimens have been recorded from Boundary and Bonner counties. It prefers grassy meadows and openings, both marshy and dry, along streams in the Canadian zone.

Microtus montanus nanus. Mountain Meadow Mouse.—This small subspecies is known in northern Idaho only in Clearwater and Idaho counties. It is a dweller of the high mountain grassy slopes, mostly in the Hudsonian zone. Their homes are in underground burrows, the entrances partly concealed by grasses.

Microtus longicaudus mordax. Long-tailed Meadow Mouse.—This species has been recorded from seven of the ten northern counties, the exceptions being Benewah, Latah, and Nezperce. It ranks next in abundance to the white-footed mouse (*Peromyscus m. artemisiae*) in Kootenai and Shoshone counties as determined by trapping experiments by the writer. Open dry grassy meadows near streams are a preferred habitat at elevations around 3,000 feet. They also occur at higher elevations in moderate numbers.

Microtus richardsoni macropus. Richardson Meadow Mouse.—This large meadow mouse inhabits the higher altitudes, usually in the Hudsonian zone. It is semiaquatic in habit, being an expert swimmer and diver. It lives mostly in burrows along stream banks and when in danger depends somewhat for protection on swimming or diving in the mountain streams. It has been recorded from Bonner, Shoshone, and Idaho counties at elevations up to 6500 feet.

Ondatra zibethica osoyoosensis. Muskrat.—The muskrat is still fairly well distributed in northern Idaho. The Region One U. S. Forest Service annual report on wildlife for northern Idaho for the year 1941 estimates the number of muskrats as follows: Coeur d'Alene, 1100; Kaniksu, 1300; Nezperce, 400; St. Joe, 600. The estimated catch by trappers was 770 skins.

Rattus norvegicus. Norway Rat.—While the Norway rat has been established on the west coast for many years past, it is only recently that it has made its appearance in northern Idaho in large numbers. It was first reported from the Coeur d'Alene mining region at Kellogg, Shoshone County, in August 1932. On April 15, 1939, I secured a specimen that was trapped in a barn near Coeur d'Alene, Kootenai County. The location was but a few miles from the large city garbage dump. On the nights of February 27 and 28, 1941, two large invasions of rats took place in the north section of Coeur d'Alene. Grocery stores, warehouses, and private homes were invaded. The largest specimen that I secured following the raids was a male measuring: total length, 439 mm; tail, 202; hind foot, 44. Campaigns to destroy them were started and through poisoning, trapping and shooting thousands were killed. This caused many rats to leave the dump grounds and spread out through the outlying farming communities. Large numbers were reported as far south as Lewiston, Nezperce County, in February 1941, and as increasing in numbers in 1942–43. In November 1944, rats were reported in large numbers from St. Maries, Benewah County, and from there they had followed the watercourses and had reached Avery on the headwaters of the St. Joe River, Shoshone County.

Mus musculus. House Mouse.—House mice probably occur in all of the settled portions of northern Idaho, as well as in suitable fields and dry meadows. Many of them leave outside habitats and seek food and shelter in human habitations during the winter months. Adult male specimens trapped in basements in Coeur d'Alene, Kootenai County, during the month of February averaged 162 mm in total length; young males taken at the same time averaged 125 mm. Males were found to outnumber females in dwellings six to one.

Zapus princeps kootenayensis. Rocky Mountain Jumping Mouse.—This jumping mouse has been collected in Boundary, Bonner, Kootenai, and Shoshone counties and its range extends as far south as the Clearwater River drainage where it intergrades with *Zapus*

princeps idahoensis. I have found it fairly common in open dry meadows in the Canadian zone on the Coeur d'Alene National forest in Kootenai and Shoshone counties.

Zapus princeps idahoensis. Rocky Mountain Jumping Mouse.—This subspecies ranges as far north as Latah County. Specimens have been recorded from two miles east of Weippe, Clearwater County and from Cedar Mountain, Latah County.

Erethizon epixanthum epixanthum. Yellow-haired Porcupine.—The yellow-haired porcupine is a fairly common inhabitant of both the Transition and the Canadian zones throughout the wooded areas of northern Idaho. The Region One U. S. Forest Service annual report on wildlife for northern Idaho estimates the number of porcupine for 1941 as follows: Bitterroot, 450; Clearwater, 1500; Coeur d'Alene, 850; Kaniksu, 2200; Lolo, 400; Nezperce, 2800; St. Joe, 2800. Their presence in a wooded area is revealed more often by bark fragments and twigs lying around the base of trees where they have been feeding than by the presence of the animals themselves. During the winter months when there is deep snow, they spend much of their time in the tree tops. In summer, they are a nuisance around occupied cabins and camps, especially at night. In recent years with the greatly increased value of forest trees for lumber, it has become necessary to control the porcupine because of the damage caused by girdling.

Ochotona princeps princeps. Pika.—In northern Idaho this subspecies has been recorded from Shoshone and Idaho counties. It also occurs on the Coeur d'Alene National Forest in Kootenai County and in many of the rock slides on the higher elevations of the St. Joe National Forest in Shoshone County in association with the hoary marmot (*Marmota caligata nivaria*).

Ochotona princeps cuppes. Pika.—This subspecies is known only from the Cabinet Mountains in the extreme northeastern portion of Idaho in Boundary County.

Lepus townsendii townsendii. White-tailed Jack Rabbit.—To my knowledge the white-tailed jack rabbit has not been reported previously from northern Idaho. I first became aware of its presence in Kootenai County in October 1926 while hunting on the Rathdrum Prairie near Rathdrum. I found the remains of one at the base of an old haystack, of another in thick weeds along a railroad embankment, and of one that had been run over by traffic on the main travelled highway. This species has also been seen occasionally along the borders of wheat fields in the vicinity of Worley, Kootenai County, since 1929. On September 9, 1930, I flushed an adult from tall grass in the vicinity of Coeur d'Alene, and several nearly full-grown animals from among thick pine reproduction near Huetter a short time later. On December 18, 1943, a large male of this species was struck by an auto at night on the highway a short distance west of Heutter, Kootenai County. This specimen was given to me and I made it into a study skin. The skull was badly smashed and the hind legs were crushed. Mr. Stanley G. Jewett, Portland, Oregon, confirmed my identification. This species has also been known to occur in the vicinity of Pullman, Washington.

Lepus americanus bairdii. Snowshoe Hare.—The snowshoe hares are fairly well distributed throughout the wooded areas of northern Idaho. They inhabit mainly the Transition and Canadian zones, occurring occasionally in the Hudsonian zone. Their abundance varies in different years. They are the common prey of the Canada lynx, bobcat, coyote, red fox, and the larger owls. It is no unusal sight to see their discarded remains hanging from the tops of tree stubs or other suitable perches where they have feasted on by owls. Also, their remains are often found at the entrances to red fox dens in the spring.

Sylvilagus nuttallii nuttallii. Nuttall Cottontail.—This cottontail has been recorded from Lewiston, Nezperce County, and Fiddle Creek, Idaho County. While I was aware of its presence in Kootenai County as far back as 1915, I did not collect specimens until October 1926, at which time the rabbits were fairly well distributed in brushy areas in the open ponderosa pine stands in the Transition zone. They are still present in moderate numbers in the same type of habitat from Coeur d'Alene west to the state line near Spokane Bridge, Washington, and east as far as Rathdrum, Kootenai County.

Cervus canadensis nelsoni. Elk.—Lewis and Clark on their return journey over the Lolo trail in June 1806 were informed by their Nezperce Indian guides "that there is an abundance of elk in the valley near the fishery on the Kooskooskee," a river in Idaho County

now known as the Lochsa Fork of the Clearwater River. This area is still the location of the largest of two native elk herds in northern Idaho. The other is in the southern portion of Shoshone County. The yearly census of elk on the National Forests in northern Idaho is given in Table 1.

In addition to the two known native herds, there are two roving bands of elk, one along the Clearwater divide on the Shoshone County side, the other near the Clearwater and Montana divide. Besides these, there were eight plantings of elk in northern Idaho between 1925 and 1939 — three on the Coeur d'Alene National Forest, totalling 174 head; two on the Kaniksu, totalling 45 head; and two on the St. Joe, totalling 87 head. Of these, 277 were brought from Yellowstone National Park; 29 from the Montana Bison Range.

The average measurements of eight bulls gave a total length of 2,375 mm; tail, 125; hind foot, 625; ear outside, 200; of 21 cows, 2200—112—575—175. Mature bulls weighed from 700

TABLE 1.—*Yearly census of elk on National Forests in Northern Idaho, as estimated by Region One U. S. Forest Service for the years 1919 to 1942, inclusive*

	BITTERROOT	CLEARWATER	COEUR D'ALENE	KANIKSU	LOLO	NEZPERCE	ST. JOE
1919	—	200	—	—	—	256	100
1920	—	200	—	—	—	250	100
1921	—	200	—	—	—	115	60
1922	—	180	—	—	—	237	71
1923	—	250	—	—	—	110	70
1924	—	450	3	—	—	334	65
1925	—	500	5	—	—	309	75
1926	—	630	61	—	—	320	115
1927	—	670	75	—	—	303	125
1928	—	710	85	—	—	360	127
1929	—	715	88	—	—	385	140
1930	—	795	85	—	—	420	187
1931	—	827	80	—	—	248	210
1932	—	600	80	—	—	225	300
1933	—	675	85	—	—	225	345
1934	—	1680	88	13	—	238	375
1935	2990	1725	124	35	1700	1690	390
1936	4000	3492	80	37	1800	3612	349
1937	4000	3500	150	50	1850	4400	600
1938	4200	3400	200	50	1850	4470	650
1939	4300	3800	260	60	1900	5020	750
1940	4600	3600	250	50	2000	4400	1100
1941	4700	3700	330	70	1900	4300	1000
1942	5100	3700	380	95	1950	4400	1100

to 800 pounds, averaging between 500 and 600 pounds. Cows weighed from 400 to 500 pounds and calves at birth, 30 to 35 pounds.

A cow elk killed and dissected provided the following data:

Total live weight	515	pounds
Weight of head	16	"
Weight of feet	18	"
Weight of paunch and contents	87	"
Intestines, including spleen and kidneys	48	"
Weight of heart	3	"
Weight of lungs	10	"
Estimated weight of blood	20	"
Total weight dressed away	214	"
Dressed weight	301	"

The amount dressed away equalled 42 percent of the live weight. The length of one digestive tract was approximately as follows: esophagus, 2 feet; stomach, 2 feet; small intestines, 42 feet; caecum, 8 feet; large intestine, 18 feet; total, 72 feet. The paunch and contents weighed 87 pounds; weight of paunch alone, 3 pounds; contents dried, 12½ pounds. The capacity of the paunch was 9½ gallons.

The breeding season in northern Idaho extends from the middle of September to the middle of October. Elk are polygamous and the average number of cows in the harem of one bull is five or six with variations of two to sixteen. The gestation period is from 249 to 262 days, with the usual calving period lasting from the middle of May to near June 15, the peak being about the first of June. The sex ratio of calves is about 47 males to 53 females. Twins are uncommon. Most of the calves are born on the winter range where early plant growth provides desirable feed for the lactating mothers. The calves are hidden by their mothers for three or four days and when they are strong enough to travel, the cows migrate to the summer range. The calves nurse until about six weeks old and then begin eating small quantities of forage. They retain their spots until late in July, and by the latter part of September the change to winter pelage is complete.

Elk are both grazers and browsers, and travel considerably while feeding. Their food in volume as determined by stomach analyses by the U. S. Forest Service consists of conifers 11.75%, shrubs 15.46%, grass like plants 8.39%, grass 56.58%, weeds 2.35%, and mosses and lichens 5.25%.

Loss from predators is usually not very large in northern Idaho, the estimate for 1941 being 90 head. The loss from starvation, disease and poaching that year was estimated at 770 head, and the kill by licensed hunters at 2800 head.

Odocoileus hemionus hemionus. Mule Deer.—The mule deer is well distributed over the forested areas of six of the ten counties comprising northern Idaho. The U. S. Forest Service Region One 1941 game census for northern Idaho estimated the number of mule deer as follows:

FOREST	ACRES	NUMBER OF DEER	ACRES PER DEER
Bitterroot	830,105	4,500	185
Clearwater	1,144,312	1,200	954
Coeur d'Alene	801,999	400	2,005
Kaniksu	1,051,635	3,400	309
Lolo	509,278	100	5,092
Nezperce	1,976,045	8,800	225
St. Joe	1,073,275	1,600	671

This census shows that on the Bitterroot, Kaniksu, and Nezperce forests mule deer are numerous. A comparison with the table for whitetail deer shows mule deer to be the most numerous on the forests having the smallest number of white-tailed deer. Higher elevations, remoteness, and more open country may be partly accountable for the large number of mule deer on certain of the forests.

During a contest in 1933 for large deer killed in the northern counties of Idaho, 15 mule deer bucks taken in the open hunting season were entered. Their weights varied from 190 to 298 pounds, with an average of 248 pounds hog dressed. Allowing 25 percent more for live weight would raise the average to 310 pounds for live mature bucks. The heaviest weight record that I have for a mule deer buck in north Idaho is 367 pounds hog dressed or around 459 pounds live weight. No weights are available for mule deer does.

The mule deer bucks prefer the remote areas in the higher and rugged portions of the Canadian and Hudsonian zones while the does with fawns usually remain at lower elevations. The bucks remain in the high areas until driven down by deep snow. They are able to secure browse in snow from 2½ to 3 feet deep, but will seek lower elevations where available and in severe winters will migrate in large numbers for considerable distances to suitable winter feeding grounds on southern exposures.

The breeding season in this area occurs from the middle of October through November. The fawns are usually born in June, twins being more common than singles. The bucks shed their antlers in February or March and begin growing new ones early in May. They are usually full grown by the latter part of August and the velvet is rubbed off in September. The fawns shed their spots when their first winter coat comes in late in September or early in October. More than 100 species of plants are known to be taken as food by the mule deer in northern Idaho. From extensive studies of stomach analyses made by the U. S. Forest Service it has been found that the usual mule deer diet consists of conifers 13.41%, shrubs 40.24%, grass like plants 3.66%, grass 9.76%, weeds 25.61%, mosses and lichens 7.32%. The ten most important or palatable species of winter forage consists of Douglas fir, western red cedar, lodgepole pine, Oregon grape, kinnikkinnick, goat brush, willow, snowbush, serviceberry, and juniper.

The mountain lion is the most destructive predator of the mule deer, with the coyote next in importance. The coyote's most favorable time of attack is during deep snowfall. The estimated kill of mule deer by predators during 1941 was placed at 1100, the loss from sickness, disease and starvation at 960, making a total of 2060 head.

Odocoileus virginianus ochrourus. White-tailed Deer.—This species is mostly an inhabitant of brushy slopes, ravines, and meadows at elevations of 2300 to 3500 feet, in the higher levels of the Transition and the lower levels and valleys of the Canadian zones. Availability of cover and forage in summer and winter has much to do with the shifting of the deer population from the higher to the lower elevations. Two feet of dry snow is about the maximum depth in which these deer can secure sufficient forage to exist. The annual wild life census of Region One U. S. Forest Service lists the number of white-tailed deer on the National Forests of northern Idaho in 1941 as follows:

NATIONAL FOREST	ACRES	DEER	ACRES PER DEER
Bitterroot	830,105	1,000	830
Clearwater	1,144,312	450	2,543
Coeur d'Alene	801,999	1,800	446
Kaniksu	1,051,635	8,400	125
Lolo	509,278	150	3,395
Nezperce	1,976,045	6,100	324
St. Joe	1,073,275	2,100	512

During the open hunting season in 1933, a contest was conducted at Coeur d'Alene, Idaho, with a prize offered for the heaviest deer killed in the upper counties of northern Idaho. Twenty-one white-tailed bucks and two does were entered against 15 mule deer bucks, the former having a handicap of 40 pounds. The deer were hogdressed and carefully weighed as entered. The white-tailed bucks varied from 170 to 260 pounds, with an average of 203 pounds. The two does entered weighed 135 and 150 pounds respectively. The mule deer varied from 190 to 298 pounds with an average of 248 pounds. With the allowance of the 40 pound handicap a white-tailed deer buck carried off the prize. Allowing 25 percent of dressed weight lost in the dressing, the average live weight of mature white-tailed bucks is 253½ pounds; that of does around 178 pounds.

The mating seasons occurs during October and November. The fawns, commonly one, occasionally two, are born from the middle of May to the middle of June. By early July they are weaned and feeding with the does and by early September they begin to loose their spots.

The food of this white-tailed deer is known to consist of more than 100 species of native plants, different parts of which are eaten at various seasons of the year. A heavy snowfall usually drives all the deer and elk from their summer haunts to lower levels. The white-tailed deer under these conditions will move to the lowest levels and feed on willows growing along lake shores in close proximity to civilization.

Alces americanus shirasi. Moose.—Moose have never been very numerous in northern Idaho. The Coeur d'Alene Indians who inhabited and hunted over a considerable portion of northern Idaho are of the opinion "that moose always inhabited the Coeur d'Alene country but were nowhere very plentiful." The big game estimate of Region One U. S. Forest Service for northern Idaho lists the moose population for 1942 as follows: Bitterroot, 70; Clearwater, 120; Coeur d'Alene, 1; Kaniksu, 5; Lolo, 100; Nezperce, 65; St. Joe, 86. The greatest numbers are found in remote areas where suitable feeding grounds of swampy land and shallow lakes are present. There has been no open hunting season on moose in northern Idaho, but hardly a year goes by but what three or four are killed by elk hunters, presumably by mistake. Moose occasionally leave their haunts in the forests, especially during a bad fire season, and roam over the highways. A large bull moose was observed on Sept. 25, 1926, on a well travelled highway six miles northwest of Coeur d'Alene City.

Rangifer montanus. Mountain Caribou.—The earliest known account of the mountain caribou occurring in northern Idaho in the present Boundary and Bonner counties comes from the Indians whose traditions are that they hunted them there long before the coming of the white man. This caribou is a migratory species and it would be an easy matter for them to follow down the Selkirk Range from British Columbia into Idaho and travel into Montana on the east or Washington on the west. If the caribou was ever a permanent dweller in northern Idaho it was before early settlement began. I have no information of caribou calves being seen south of the boundary. Tracks of as many as 25 to 30 adults were reported from north western Montan near the Idaho boundary as late as 1920, but no reference was made to calves. Numerous shed antlers have been found in the upper Priest Lake country in Boundary and Bonner counties, Idaho, in recent years, which indicates overwintering in those areas. Old time trappers residing at Porthill, Idaho, near the international boundary reported caribou on the head of Boundary and Smith creeks as late as 1933. On October 21, 1937, two caribou, adult male and female, were killed on the headwaters of the south fork of the Salmo River in Pend Oreille County, Washington. They were supposedly mistaken for mule deer by the hunters who promptly reported their error to the local game warden residing at Newport, Washington. This river traverses the northwestern portion of the Kaniksu National Forest in Washington, crosses into Idaho and then flows north back across the Canadian boundary. As the caribou were killed but a few miles west of the Idaho boundary, it is likely that they still occur irregularly in northern Idaho.

Antilocapra americana americana. Pronghorned Antelope.—My mention of antelope occuring in northern Idaho is based on the traditions of the Coeur d'Alene Indians. According to them, antelopes were abundant in the Spokane country, especially on Spokane Prairie, until about 1820, but they inhabited only a small fringe of the Coeur d'Alene country around Hangmans Creek which was their eastern limit. The last of them were killed in this section about 1820, but they persisted farther west in the countries of the Spokane and Columbia, until much later. An open prairie of approximately 100 square miles in what is now Kootenai County constitutes the area over which the antelope apparently roamed in northern Idaho.

Ovis canadensis canadensis. Bighorn Sheep.—The bighorn formerly occurred throughout most of the mountainous portions of northern Idaho, but is is now restricted to the higher ridges and peaks on the Idaho portion of the Bitterroot and Nezperce national forests in Idaho County. The estimated number on the former in 1941 was 80 head; on the latter, 120 head, making a total of 200. The estimated loss from hunting, predators, and disease in 1941 was 30.

Oreamnos americanus missoulae. Rocky Mountain Goat.—Mountain goats probably occurred in all the high mountainous portions of at least eight of the ten counties of northern Idaho prior to settlement. They are now restricted to the higher peaks of Boundary, Bonner, Shoshone, Clearwater, and Idaho counties. The Region One U. S. Forest Service wild life census for northern Idaho for 1942 estimated the population as follows: Bitterroot, 900; Clearwater, 400; Kaniksu, 180; Lolo, 50; Nezperce, 110; St. Joe, 95.

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Coeur d'Alene, Idaho.

PARTURITION IN A WEST INDIAN FRUIT BAT (PHYLLOSTOMIDAE)

BY T. S. JONES

An opportunity to observe and study parturition in a fruit bat, *Artibeus planirostris trinitatis* (K. Anderson), arose during general work on the habits of some common bats in Trinidad. The genus *Artibeus* in the family Phyllostomidae consists of several species and subspecies found throughout the warmer parts of America and the West Indies. The local subspecies is very abundant in Trinidad, commonly occuring in small groups in such habitats as caves, under dense shade in trees, under eaves of houses, in old disused boilers, etc. It is commonly in evidence during twilight when it may frequently be observed feeding around sapodillas (*Achras sapota* L.), mangoes (*Mangifera indica* L.), and other fruits that are in season at the time. The soft tissue of the Angelin fruits (*Andira inermis* H.B.K.) and Tonca beans (*Dipteryx odorata* Willd.) are frequently removed from the tree and carried to nearby feeding places where small heaps of the stones of these fruits may be found.

Present knowledge of the parturition of bats is rather fragmentary. Parturition in the Vespertilionidae has been most frequently studied. It was investigated in *Nyctalus noctula* (Schreber) by Daniell (1834) and Whitacker (1905); in *Myotis myotis* (Miller) by Jobert (1872) and Rollinat and Trouessart (1896); in *Myotis austroriparius* (Rhoads) by Sherman (1930) and in *Myotis lucifugus lucifugus* (Le Conte) by Mohr (1933) and Wimsatt (1945). Parturition in a representative of the Molossidae, *Tadarida cynocephala* (Le Conte), has been described by Sherman (1937). Apart from these two families little appears to be known. Blake (1885) observed parturition in a member of the Phyllostomidae which appears to be the only record for this family. He obtained from a cave in the Bahamas Islands a single female specimen in an advanced stage of pregnancy and kept it alive in a large box. No name is given, but Allen (1940), commenting on it, suggests that it was probably the common long tongued *Erophylla planifrons* (Miller) of the subfamily Phyllonycterinae. For comparison with the present observations a short summary of his account follows.

Parturition began at noon a few days after capture and at that time the bat was hanging in its usual posture suspended by one foot, the other being bent forward at right angles. Labor paroxysms of a few seconds duration took place every two minutes. The bat then hung by both hind legs and bent its body backwards as if in much pain. At 12.20 p.m. the left hind leg of the young bat appeared, doubled forward at the knee joint. The mother still hung most of the time by one foot and used the other to scrape the amnion and to scratch herself.

The amnion finally broke, after which the young one straightened out its leg and grasped the mother's wing. The mother then hung by her right leg, bending the left one until the foot of the young one hung on to it, and then she gradually drew the young one up by raising her leg. By 12.30 p.m. the second leg was free and both legs at once grasped the mother and five minutes later the young one was fully excluded, having been born on its back, breech first. After this the mother licked it for half an hour and later it suckled satisfactorily. The placenta had come away at 1.00 p.m. and was eaten by the mother. The young one unfortunately died the next day.

Several specimens of *Artibeus planirostris trinitatis* of the subfamily Stenoderminae were obtained at St. Augustine, Trinidad, on June 22, 1945, from a group of about 20 under the eaves of a house. All were in an advanced stage of pregnancy. In this species the sexes appear to segregate when the females are pregnant, the females usually being found together in groups of 10–20 while the males are at that time found in ones or twos under banana leaves or in similar retreats in the surrounding area.

One specimen was separated and kept in a wire mesh cage where it hung suspended from the top by both feet, in a position where it could easily be observed. It remained quiet overnight but appeared very restless all the following day (23rd). During the day the young *in utero* was noticed moving convulsively at frequent intervals; this appeared to cause the bat a good deal of pain as after each movement she stiffened, pulled her body up by the feet, at the same time baring her teeth and opening her mouth. This continued all day with short periods of sleep until about 4.00 p.m. when she cleaned herself, hanging by one foot and licking her wings and body. During the evening she ate a portion of a ripe banana and drank some water from a shallow dish. After this she was restless all night, moving backwards and forwards across the cage, stopping only when she was apparently in pain. Just before 6.00 a.m. on the 24th, she was found hanging from the roof of the cage by both feet. Labor movements of a few seconds duration were occurring about every 3 minutes and the fetus had changed from a transverse to a longitudinal position. At 6.10 a.m. the head started to emerge slowly, the mother still hanging by two feet. The amnion was ruptured before parturition commenced, possibly by the previous convulsive movements of the young one, and at this stage amniotic fluid was noticed. It took 6 minutes for the head to emerge fully; this was followed by a rest of 2 minutes, during which the mother dropped her right leg, bending it at the knee. The foot, however, was not used at any time to help the young one. During this short resting period she licked the protruding head of the young one several times. Labor then continued, the mother closing her eyes during each spasm. At 6.18 a.m. the shoulders of the young one emerged, followed within a minute by the whole body, except the feet. Not until this stage did the young one make any movement, but it now gripped the mother with its thumbs and freed its own feet. Parturition thus took approximately 9 minutes.

As soon as the young one showed signs of life, the mother folded her wings round it, began licking it all over and then licked her vagina. The young one

subsequently began a vigorous search for a teat and at every slight movement of the mother, made sucking and cheeping noises, which the mother answered with chattering notes. At 6.35 a.m. the mother was hanging up by both feet again and the young one, by then having found a teat, was sucking vigorously. At 6.40 a.m. the mother again licked the young one all over and after this folded her wings to rest, continuing for some time to lick both the young one and herself. The placenta came away and the umbilical cord was severed approximately 4 hours later. Although not observed, the placenta was probably eaten by the adult as the only trace found, was a small piece of tissue.

On the whole the new-born bat appeared to be in a rather more advanced state than in the cases of those of other families that have been described. Daniell (*op. cit.*) states that in *Nyctalus noctula* the young one at birth is blind and destitute of hair, and Sherman (1930) observed in the young of *Myotis austroriparius* that the eyes and ears are closed and it is naked except for a few hairs on its toes and knees. These two species are both in the family Vespertilionidae and may differ in many respects from those of other families. The young *Artibeus* whose mode of presentation is described above was extremely active immediately after birth and was born with its eyes open. This latter state does not appear to be usual as previous to the present case [Jones (1945)] it had only been noted in *Tadarida cynocephala* by Sherman (1945). The young bat also had its head, back, forearms, and interfemoral membrane covered with hairs which were more noticeable after it had dried. The evening after parturition, the young bat, which appeared well fed, hung up by itself while the mother ate a portion of a banana. In the natural state this is probably not usual, as the adults have been observed to carry the young ones until they are about 10 days old.

This present account differs in several particulars from that of Blake, showing that major differences may occur between species of the same family. The greatest difference is possibly that in the case observed by the writer, presentation was head first, whereas Blake (*op. cit.*) states that presentation was breech first, as it is in most other recorded cases. Daniell (*op. cit.*) and Whitacker (*op. cit.*), however, both describe head presentations in *Nyctalus noctula*. Thus, although breech presentation appears to be usual in most species of bats so far studied, there are exceptions which may possibly be abnormal births. In Blake's example the young one helped itself out, whereas in the present case the young one remained without a movement until almost entirely presented. In both cases the adult hung by one foot, a position which on the scanty facts already known appears to be limited to the Phyllostomidae, but in the present case the mother did nothing to help the young one with the free foot as in the case described by Blake. This, however, may be due to the fact that in this particular case the amnion was already ruptured and as the head of the young one appeared first, little could be done to help without the possibility of an injury to it.

In Table 1 the sizes of two young at birth as compared to the adults are given. It is interesting to note that the hind foot, thumb, and nose leaf are nearly fully grown at birth as compared to the body, forearm, and wing, which gives the young one a disproportionate appearance.

TABLE 1.—*Size of young Artibeus planirostris trinitatis at birth compared with adult females* (Measurements to the nearest mm.)

	HEAD AND BODY	FOREARM	WING-SPAN	HIND FOOT	EAR	NOSE LEAF	THUMB
Adult female	78	59	431	15	23	14	11
Young at birth	54	34	221	13	14	10	10
Adult female	77	59	422	14	22	13	10
Young at birth	53	32	220	13	13	10	10

SUMMARY

The present scanty knowledge of parturition in bats is noted, particularly in the large family Phyllostomidae. A detailed description of the parturition in *Artibeus planirostris trinitatis* (Phyllostomidae) is given. Presentation was head first, not breech first as in most of the previously recorded cases, and the mother gave no help to the young one during parturition. The young one was also born in a more advanced state than in most recorded cases, particularly in having its eyes open.

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THE CAROLINA BEAVER: A VANISHING SPECIES?

By J. Clark Salyer II

The dangerously low population level reached by the Carolina beaver (*Castor c. carolinensis*) is clearly expressed in Glover M. Allen's excellent work "Extinct and Vanishing Mammals" (1942), in which he states: "The limits of the range of this race, though in general from northern Florida to the Mississippi and northward to the lowlands of New Jersey and Ohio, Indiana, and Illinois will probably never be exactly definable since *it is now extinct over the greater part of the area*" [italics mine]. In a slightly more optimistic vein he adds, " . . . information is meager, but it indicates that the animals still hold out in a few widely separated localities where, with *real protection*, there is some hope that they may continue and even increase *considerably*" [italics mine].

Realization in recent years of the predicament of this beaver has led some states within its range (notably Georgia, Alabama, and Mississippi) to protect their few remaining colonies more vigorously. With the development of the National Refuge Program, the Fish and Wildlife Service of the U.S. Department of the Interior also has been throwing its influence on the side of this harassed mammal and since 1940 the Carolina beaver has been introduced on several refuges located in the southeastern United States with most promising results.

The Piedmont Refuge, Jasper and Jones counties, Georgia, a 28,500-acre tract of land situated in the Piedmont Region, was the first of several national wildlife refuges selected for this venture. According to local landowners, no beavers had been seen in the general area in the 10 or 15 years preceding the refuge's establishment in 1939. Those few animals made their last stand in the vicinity of a small stream known locally as Stalkinghead Creek, probably near what is now the northern limit of the refuge. They were killed off by farmers, purportedly, to prevent damage to crops growing along the creek's banks. Part of a former Resettlement project in Georgia, these lands had been farmed intensively by sharecroppers with cotton as the major crop—a combination definitely inimical both to the soil and its wildlife. Not overlooking the role of the beaver in the program of soil and water conservation, it was with a twofold purpose that in the spring of 1940, three animals secured from the Georgia State Division of Wildlife were placed on Falling Creek, one of the larger refuge streams. Three more animals were released in the same locality later in the year. By early winter it was found that the beavers had moved a short distance downstream and had selected a narrow part of the creek where the steep and wooded banks provided a satisfactory winter home.

Extending their sphere of influence along the stream in the next two years, the beavers constructed several dams, one of which backed water 500 feet upstream. Late in 1942, a colony boasting three dams was located at the junction of Falling Creek and Stalkinghead Creek, 2½ miles north of the original point of release.

By the fall of 1943 it was definitely established that at least two colonies existed on the refuge and the success of the restocking seemed no longer in doubt. A third release was made in 1944 when two adult beavers and five young-of-the-year

were taken along the Flint River from one of the few remaining colonies in Georgia. Altogether 13 animals have been placed on the Piedmont Refuge since 1940 and by summer of 1945 not less than 20 beavers were to be found along Falling Creek and connecting channels. Dog fennel (*Eupatorium compositifolium*) has been an attractive food item in the middle and late summer months, and numerous paths can be traced leading from the stream's edge to plants 200 feet away while other herbaceous vegetation growing nearby is untouched.

The 39,000-acre *Carolina Sandhills Refuge*, located in Chesterfield County, South Carolina, with its 8,600 acres of swamp and hardwood forest lands and 12 small impounded lakes, offered the beaver every inducement to thrive. So, in the early winter of 1940–1941, six animals were liberated on the 27-acre Martin's Lake, largest of the refuge impoundments. Little was seen of the animals the following year, but by 1942 it was evident from the signs they left that beavers were using at least six other lakes on the refuge. Seen more frequently in 1943, it was not until 1944, however, that any construction work was done; in this year a rapid increase took place and "signs" were found on practically all of the refuge lakes. A small water area known as Lake 17, 1½ miles from the point where the beavers were first released, was the site of their first house, and by late summer three small dams had appeared on the lake's spring head. Later that season, when it was necessary to lower the lake, the beavers immediately responded by building a 100-foot dam between the original lake level and the dam farther upstream. This project they accomplished in the short period of two days.

By the spring of 1945, beavers were a common sight along refuge streams and lake shores. Nine active lodges were found on one small lake alone. The adaptability of the beaver was high-lighted on one lake where the water-control structure had been converted into a house and the bleeder pipe was being used as an exit. In June 1945 Refuge Manager Holland, while working over the upper reaches of Martin's Lake, came across a beaver dam approximately 500 feet long. It formed a small lake covering some five acres and the water just above the dam was 7 feet deep. A large house had also been built a few hundred feet below the dam. The volume of water pushing against the dam, as well as its velocity, must have kept the beavers "on their toes" as maintenance of the dam required considerable application. Obviously the Carolina beaver has not fared badly on the Carolina Sandhills Refuge when one considers that from the six animals placed there late in 1940, their numbers had swelled to over 50 in the spring of 1945.

Lands within the *Noxubee Refuge*, comprising 38,000 acres in Winston, Noxubee, and Oktibbeha counties, Mississippi, were formerly well populated by beavers. A colony, the result of a State release in 1937, still persisted near its western boundary at the time the refuge was placed under administration in 1940. Awaiting the beaver was an excellent habitat of wooded lands traversed by 27 miles of watercourses, 12 of which were suitable beaver streams. The remaining 15 miles of streams, although intermittent in character, still retained numerous deep holes within their banks during the late dry summer months. Browse grew abundantly along the stream banks and many kinds of food plants used by the Carolina beavers occurred on the refuge.

Thus, hoping to improve the habitat for woodducks, as well as aid the beaver, four animals, secured through the cooperation of the Mississippi Game and Fish Commission, were released on Loakfoma Creek in March 1941. This particular site is well within the refuge, far from private holdings, and permits freedom of movement up and down stream with slight chances of the animals leaving protected lands. Rapidly adjusting themselves to their new location, the beavers soon built four dams about three miles below their point of release. This first year proved a dry one and put the new residents to a severe test, but they busied themselves with extensive cutting operations, meanwhile appropriating the deepest water they could locate in that part of the stream. Of interest to observers was their tendency to cut large trees while saplings of the same species stood nearby untouched. One day the refuge manager came upon a beaver busily digging at the base of a pine tree. Watching quietly for some time, he then saw the animal strip the bark from the exposed roots and eat it with apparent relish. This behavior was repeated on several later occasions.

During 1942 the refuge was the scene of great activity. Eleven dams built by them along Loakfoma Creek formed a series of small pools extending a half mile down stream. Even the colony along the Noxubee River just west of the refuge that had been showing signs of moving onto refuge land industriously built a dam across the river and dug two channels which maintained water in as many nearby sloughs. A third locale of activity centered about a small but permanently flowing stream on the refuge at some distance from any previously known colony. Thus, although 1943 was a dry year, the tempo of the beaver expansion in the refuge did not stop.

By the spring of 1945, beaver signs were to be found scattered over the entire refuge along its various creeks and sloughs as well as on the Noxubee River and 16 active dams and 5 active houses were counted on refuge lands and 2 or 3 houses were found on private lands a couple of miles above the refuge boundry. Beavers use stream banks for houses to a large extent in this area and fewer lodges are necessary.

With such general distribution, it is difficult to determine the total number of beaver now resident on the refuge, but there is every assurance that on the Noxubee Refuge the Carolina beaver has secured another toe-hold in its struggle for existence.

The Carolina beaver made its last stand in the State of Tennessee near the present site of the *Reelfoot Refuge*, Lake and Obion counties, on the shores of the long-famous Reelfoot Lake. What would appear to be the last records extant of its occurrence in the state were made by Samuel N. Rhoads in 1895, at which time he was taken to see a beaver house in a cypress swamp near Reelfoot Lake. At that time he was told that no more than 20 beaver remained in the locality—this in an area once so rich in the species that public officials received their pay in its pelts. It seems definite that when the 9,300-acre Reelfoot Refuge was established in 1941, in cooperation with the Tennessee Department of Conservation, no beavers had existed in the general locality for several years. Careless agricultural practices of the past decades and the resulting erosion had produced a slow filling-in of the lake as the rich top-soils were carried down from the sur-

rounding uplands. Siltation at the mouths of the various creeks, followed by the ubiquitous willow and giant cutgrass, resulted in a decrease of the value of the lake to wildlife and sportsmen alike.

As an ally in the control of willow growth, two pairs of beaver were secured from the Potts Camp Colony in Mississippi in 1941 and released on the southern end of Grassy Island in Reelfoot lake. During the first year many willows were cut, as had been anticipated, and one pair, apparently the two older animals, built a house near where they were released; the younger beavers wandered about indiscriminately. A second house appeared in 1942 near that of the first pair. Only casual glimpses of the animals were to be had during 1943 and 1944, but increased activity was noted in the spring of 1945 when a third house was under construction. Other signs of industry included a dam and an underwater channel leading from the beaver house built in 1941 to a nearby bayou. According to an "old-timer" who lives near the refuge, this channel follows the course of one used by beaver many years ago. Based on sight observations and the extent of their activity in the refuge in 1945, refuge personnel estimated a population of not less than 15 beavers.

The Carolina beaver, again to quote Dr. Allen, was nearly exterminated in the northern part of Alabama and although it has been able to maintain itself in some numbers in the central part of the State to the present time, it was less successful in the northern hilly regions and southern swamp areas of the state. A small number of beavers held on in the Tennessee River at Muscle Shoals until 1895, living in burrows in the river banks. At the time the *Wheeler Refuge*, Morgan, Limestone, and Madison counties, was set up in 1938, no beavers were known to be in that general area. In the fall of 1941 the state supplied three Carolina beavers, a male and two females, which were released along Flint Creek in the southern part of the refuge. The refuge has about 50 miles of shore line and stream courses affording suitable beaver habitat and an abundance of food including beech, gum, willow, cottonwood, oak, and ash. Four more animals were added to the Flint Creek group in 1942. By 1943 the new-comers showed evidence of settling permanently in their new home and TVA rebrushing crews occasionally saw beavers along this arm of the Wheeler Reservoir.

Several refuge streams in addition to Flint Creek supply desirable locations for restocking attempts and a second locale, appropriately known as Beaver Dam Creek, was selected in 1944 for the release of six beavers. If names mean anything, this stream must once have been the home of the species.

Habits of the two colonies have been strikingly different. The Flint Creek beavers have not built dams to date but by the summer of 1945 had constructed two bank dens and the investigators thought there were more in the vicinity. Hackberry and gum appeared to be their preferred foods. Trees that average from 4 inches to 3 feet in diameter are often completely ringed as high as 3 feet from the ground. In 1945 there were probably from 10 to 15 animals in the Flint Creek colony. On the other hand, those animals planted along Beaver Dam Creek promptly began cutting down trees and constructing dams and by the fall of 1944 one dam had been built and a second dam, as well as a house,

was constructed in the spring of 1945. In contrast with the Flint Creek colony, these animals have supplemented their arboreal diet with herbaceous vegetation. Probably 10 beavers are now present in the Beaver Dam colony.

The results attained by the Fish and Wildlife Service in its stocking efforts on southeastern refuges would seem to indicate that the Carolina beaver still is a virile species and can be saved from extinction.

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REPRODUCTIVE RATES AND CYCLES IN THE POCKET GOPHER

By Milton A. Miller

The rate of natural increase of a species depends in large part on its reproductive performance. Fertility is a function of many factors such as number and length of breeding seasons, number of young per litter, sex and age composition of the population, and the effect of various environmental conditions on the inherent reproductive capacity (fecundity) of the species. In the case of economic pests such as the pocket gopher, knowledge of breeding activity, especially breeding season, is prerequisite to efficient control. Accordingly, the purpose of this investigation was to determine seasonal trends, cycles, and other factors involved in the breeding performance of the pocket gopher, *Thomomys bottae navus* Merriam, at Davis, California.

Precise information pertaining to the breeding of the pocket gopher is limited, and there are few quantitative data. To obtain adequate records on breeding in most wild animals, and especially in fossorial types like the pocket gopher, one must rely mainly on post-mortem examinations of many specimens, enough for statistical reliability, collected at intervals over one or more years. These conditions are approached by Scheffer (1938) with a nine-month consecutive record on breeding in *Thomomys bottae* and *T. perpallidus albatus* (= *T. bottae albatus*) in southern California, and by Bond (1946) who gives breeding data on *T. bottae* in the same region for the spring, fall, and winter months of 1936 and 1937. Supplementary information on breeding may be obtained by mating animals in the laboratory, but the pocket gopher has not yet been bred in captivity.

Others who have contributed some data on breeding in various species of *Thomomys* from localities on the Pacific Coast are Anthony (1923), Bailey (1915), Burt (1933), Couch (1932), Dixon (1929), Horn (1923), Sagal (1942), Scheffer (1933), Storer (1942), and Wight (1930). The concensus of these reports is that in the northern and more elevated portions of this range, there is one more or less limited breeding season (spring) while in the southern regions the breeding season is more extended, coinciding with the rainy season that begins in the fall and terminates late in the spring. Correspondingly, the number of broods per year varies from one in far northern populations to two or three in southern ones. Females of certain species, however, may give birth to two broods in rapid

succession during one breeding season as shown by Burt *op. cit.* and Wight *op. cit.* for *Thomomys talpoides quadratus* in California and Oregon, and by Horn (*op. cit.*) for *T. townsendii* in Oregon. Bond (*op. cit.*) reports two marked peaks of pregnancy in *Thomomys bottae* in southern California during an extended breeding period ranging from the last of September to late in May—one peak early in November, the other about the first of April.

The basic breeding cycle of animals may be affected either favorably or adversely by various environmental factors. Through his agricultural practices, man has altered the natural conditions for existence of many species including pocket gophers. In California, extensive irrigation during the long dry season (summer and fall) has converted large arid or semiarid areas into productive green fields and orchards. In the central valleys especially much irrigated acreage is devoted to alfalfa, a crop highly prized by pocket gophers. The effect of environmental factors, particularly rainfall or irrigation, on the breeding cycle is emphasized by Dixon (*op. cit.*) who states that "the abundance of nutritious green food starts the gopher breeding," and that "where food in the form of green alfalfa was abundant, where temperature was high, as it is in the San Joaquin [Valley] in summer, and where safe breeding conditions were at hand, the gophers reared two, and in some instances three broods of young in a year." Also, Storer (*op. cit.*) states that "in irrigited regions, and especially in alfalfa fields, where green forage is available for much or all of the year, a longer if not year-round breeding season is evident." King (1927) attributes seasonal changes in the sexual cycle of lower mammals "to the effect of the rise and fall of temperature on body metabolism, not to nutrition."

Adverse effects of environmental changes on breeding have been noted by several authors. In another rodent, the eastern chipmunk, Schooley (1934) observed that "a period of unfavorable weather will cause cessation of mating activities and even the resorption of embryos already present." In gophers, resorption of embryos under "certain stresses of food relations or other untoward physical difficulties" also occurs, according to Scheffer (1938).

Various morphological indicators of breeding in both sexes have been used in studies on reproductive activity. In the female, pregnancy and the presence of placental scars in the uterus are those most commonly employed, being obviously proof of breeding. Others that may give evidence are the size and condition of the mammary glands, diameter of the uterus, and condition of the ovaries. Quantitative analysis of ovarian condition, especially in conjunction with other breeding characters, may yield valuable information on reproduction; for example, studies by Hamlett (1938) on the coyote, by Schooley (*op. cit.*) on the eastern chipmunk, by Duke (1944) on the kangaroo rat, and by the present investigation.

In the female pocket gopher another useful character is the condition of the pelvis. Hisaw (1924) has shown that the pubic symphysis of the pelvic girdle in pocket gophers is permanently absorbed at first pregnancy through the action of an ovarian hormone, *relaxin* (positively identified in 1944, Abramowitz, *et al.*), and the pubic bones become widely separated. Hence, a so-called "open" type of

pelvis clearly indicates that its possessor has bred at least once in her lifetime, while a female gopher with a "closed" type pelvis has never been pregnant.

In the male, the size and position of the testes are generally considered to be the main criterion of breeding. Enlargement of the testes and their passage from the abdomen into the scrotum supposedly indicate breeding season. In addition, Hill (1937) states that in the breeding season seminiferous tubules may be seen through the coverings of the testes of the pocket gopher and that the epididymis undergoes cyclical changes (enlarged by storage of fat during quiescent periods prior to breeding season, reduced by its depletion during and after breeding).

Additional clues pertaining to breeding may be obtained by considering the sex and age composition of periodic samples of the population. Also, since pocket gophers are remarkably solitary except in the breeding season, consideration of cases in which more than one animal is taken from a single burrow system may be instructive on such matters as mating, weaning, and dispersal of young.

In this investigation as many indicators of breeding were used as possible in determining the reproductive rates and cycles in the pocket gopher. Some proved more useful than others, and some were found to be unreliable.

ACKNOWLEDGMENTS

The author is greatly indebted to Tracy I. Storer of the University of California at Davis for use of more than one thousand post-mortem examination records collected over a period of years prior to 1944, and for many helpful suggestions during the course of the investigation and in the preparation of this paper. Grateful acknowledgment is also due to Miss Virginia Dohrmann who performed most of the autopsies and helped with the field work in 1944 and 1945. Prior to 1944, similar work was done mainly by F. J. Saunders under direction of Storer. Valuable assistance with the statistical analysis was given by Mrs. Marguerite C. Crawley.

MATERIALS AND METHODS

Post-mortem examination records on a sample of 2,283 pocket gophers taken from cultivated lands on the University of California Farm at Davis formed the basis for these studies. Of these, 1,238 were accumulated by the Division of Zoology over a period of 10 years (1932 to 1941) and covered, in the aggregate, 8 months of the year (data for July to October, inclusive, were lacking). The remainder was collected by the author over a continuous 14-month period beginning in April, 1944. The overlap of two months in the latter collection was made primarily because the samples in April and May of 1944 were small.

Most of the animals were trapped, but many were flooded out of burrows and killed during irrigation of fields; a few were recovered after death by poisoning. The bulk of the collection was taken from alfalfa fields. In most cases, the animals were autopsied within a day or two after death. In addition to the usual size measurements, biometric data on pregnancy and other previously mentioned indications of breeding were obtained.

Standard statistical procedures were applied to these records to extract the

desired information pertaining to breeding. Because of the discontinuous nature of the 1932–1941 record (data for several years are lacking, and samples for many months are small or absent), the continuous 14-month record of 1944–1945 was analyzed separately as a more homogeneous and reliable sample. Eliminated by this procedure were the possible blurring effects of different seasonal conditions in the several years on the general breeding picture. At the same time, the separate analyses permitted comparison of fertility in the gophers for various years. Data for different years were combined on occasion if no statistically significant differences were indicated. In determining reproductive trends, the data were analyzed by month, and sometimes by season.

In most parts of the analysis it was desirable to segregate adults from juveniles. A weight basis was selected as the best available criterion for separating the two groups—females of less than 100 grams and males of less than 110 grams were considered to be juvenile.

RESULTS AND DISCUSSION

Data will be presented and discussed under the following headings: (1) Breeding seasons, (2) ovarian cycles, (3) morphological indicators of breeding in the male, (4) other evidence of breeding, (5) number of broods, (6) number of young, (7) rates of increase, and (8) factors affecting breeding. Discussions will be based mainly on the collection records for 1944–1945, but any major discrepancies between these and earlier records (1932–1941) will be noted.

1. Breeding seasons.—As shown by the data given in Table 1 and Figure 1, the annual reproductive cycle of *Thomomys bottae navus* features continuous breeding, with three periods of increased fertility. Pregnant or post-partum females were taken in every month of the year but the percentage of these varies from month to month. In spring, summer, and early winter marked increases in reproductive performance occur that denote breeding seasons. Between these "peak" periods (see fig. 1) are "valleys" or "plateaus" of low reproductive performance which may be produced in part by the overlapping of late breeders from one season and early ones in the next. It should be emphasized that the above-mentioned characteristics of the annual reproductive cycle are based on gophers taken from cultivated lands (mainly from irrigated alfalfa fields) and undoubtedly would be somewhat different under natural conditions.

Pregnancy during low periods, as in the fall, drops below 10 percent while in the breeding season about one-third of the adult female population is pregnant. Low periods are characterized by large percentages of "nondescript" females *i. e.* those showing no evidence of present or recent pregnancy and no indication of suckling young, but which had bred at some former time as shown by the absence of a pubic symphysis.

Percentages of virgins (females with closed pelvic girdles) in the adult population are maintained at more or less constant low levels throughout the year, with slight increases following peak breeding periods. Virgin adults are mostly small-sized females that have barely reached maturity. Juvenile females (less

TABLE 1.—*Breeding data on female pocket gophers (Thomomys bottae navus) at Davis, California, 1944–45*

MONTH	NUMBER EXAMINED		PERCENTAGES ± S. E. OF ADULT FEMALES:			
	Total	Adults	Pregnant	Post-partum[1]	Suckling[1]	Virgin
1944						
April	26	17	35 ± 12	6 ± 6	0	24 ± 10
May	27	17	6 ± 6	18 ± 9	18 ± 9	6 ± 6
June	69	39	12 ± 5	15 ± 6	26 ± 7	13 ± 5
July	39	34	34 ± 8	9 ± 5	18 ± 6	3 ± 3
Aug.	36	30	10 ± 6	10 ± 6	20 ± 7	10 ± 6
Sept.	47	33	0	9 ± 5	3 ± 3	3 ± 3
Oct.	44	44	9 ± 4	0	7 ± 4	14 ± 5
Nov.	42	34	0	12 ± 6	12 ± 6	12 ± 6
Dec.	34	26	8 ± 5	23 ± 8	23 ± 8	0
1945						
Jan.	61	42	5 ± 3	5 ± 3	0	19 ± 6
Feb.	47	33	24 ± 8	15 ± 6	18 ± 7	3 ± 3
March	38	31	31 ± 8	32 ± 8	3 ± 3	6 ± 4
April	24	18	11 ± 7	56 ± 12	0	0
May	34	20	15 ± 8	30 ± 10	15 ± 8	10 ± 7

[1] Post-partum females have placental scars and lactating mammae. Suckling females have lactating mammae but placental scars have disappeared.

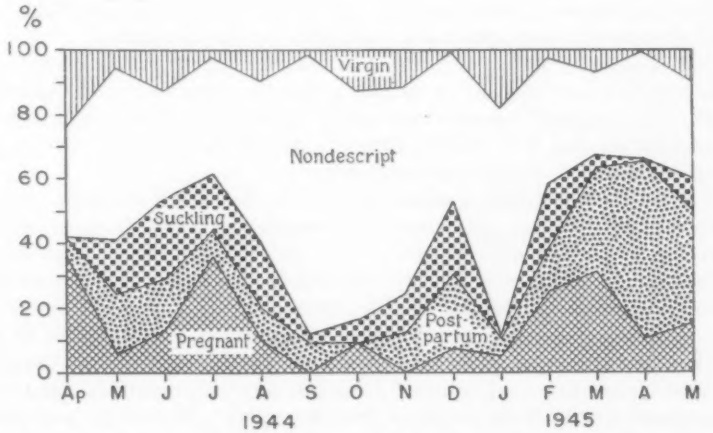

FIG. 1. Monthly composition of population of adult female pocket gophers (*Thomomys bottae navus*) at Davis, California, in respect to reproduction. Continuous breeding is indicated with peak periods in the spring, summer, and winter.

than 100 grams body weight) are predominantly virgin, although a few pregnant and post-partum juveniles were taken. The latter were close to the arbitrary dividing line (100 grams) separating adults from juveniles and constitute a very

small fraction of the breeding population. It is noteworthy, however, that of five pregnant juveniles taken in 1944–45 four were collected in summer.

That spring is the main breeding season is clearly shown by greater intensity and longer duration of breeding then than at any other season. In March and April of 1945, over 60 percent of adult females were pregnant or had recently littered. The vernal breeding season usually extends through three months, generally February, March, and April. Its length may be partly associated with the fact that some females may have two litters at this time. These may come in close sequence, as shown by records of females in early pregnancy which had enlarged mammae and presumably, therefore, were also suckling young. Females bearing one litter and suckling another have been reported in various rodents including two other species of *Thomomys*, namely *T. talpoides quadratus* (Burt, *op. cit.;* Wight, *op. cit.*) and *T. townsendii* (Horn, *op. cit.*). Further evidence supporting this view will be presented later. Spring is doubtless the main or only breeding season in the genus *Thomomys*, being somewhat earlier in southern and later in northern species.

A summer breeding season under favorable conditions has been suspected, but is here quantitatively demonstrated. In July 1944, slightly more than one-third of the adult females were pregnant, and in addition, nearly 9 percent had recently littered. The summer peak in fertility rises sharply in July from a low plateau of breeding in May and June, and drops off rapidly through August to a low level in September. A large majority of gophers collected in summer were taken from irrigated alfalfa fields, but whether the abundance of available green food stimulated breeding then is a question to be considered later.

Fall is characterized by a low level of breeding; approximately 10 percent of adult females were pregnant or recently pregnant during the autumn months of 1944. No pregnant females were taken in September and November and relatively few that had recently littered. In October, only 9.1 percent were pregnant and none showed placental scars.

The early winter breeding season is relatively minor, and seemingly varies in time of onset, duration, and intensity. Consequently, a fertility curve including breeding data for all years exhibits a broad but relatively low elevation through November, December, and January with high periods in breeding in some years filling in depressions in others. In the 1944 record, the winter peak appeared in December when about 31 percent of the adult females were pregnant or post-partum, but there was evidence of breeding in November also, even though no pregnant females were taken then. A freak in sampling accounts for the absence of pregnant females in the record for November 1944. Most of the post-partum females collected in December 1944 were taken early in that month from a field that had been trapped extensively in November. Obviously, they had been pregnant in November, but evidently eluded the traps then and were not caught until the next month after they had littered. In previous Novembers, only 12 adult females are recorded, but of these 4 were pregnant and two were post-partum. Further evidence that the estimate of fertility in November 1944 is too low is found in the ovarian analyses presented in the next part of this paper.

The winter fertility peak may merge in some years with the vernal peak through a high level of breeding in midwinter. Such might have been the case in 1935, when about 36 percent of the adult females in January and 45 percent in February were pregnant or had littered recently. (There are no data for the months immediately preceding or following). By contrast, fertility in January 1945 was only 9.6 percent or nearly 26 percent less than in the same month of 1935 (statistically, a highly significant difference with $t = 3.2$). The only other record for January, in 1933, was between these extremes, with a fertility value of 19.5 percent pregnant or recently pregnant (significantly less by the t-test than for 1935, but not significantly greater than that for 1945). Other records

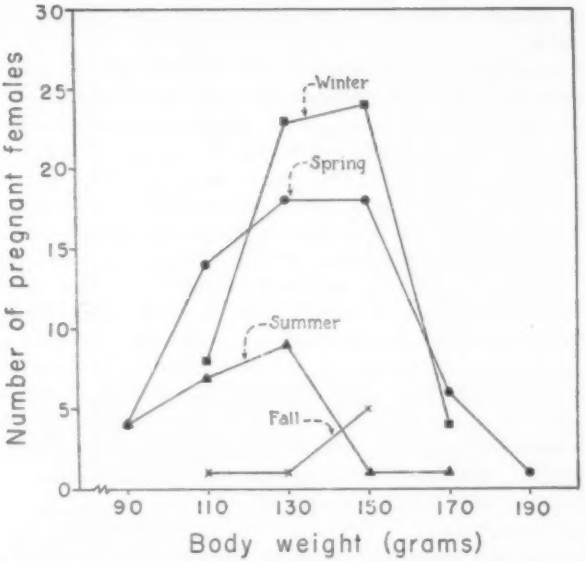

FIG. 2. Seasonal frequency distribution in weights of pregnant female pocket gophers (*Thomomys bottae navus*). Data are grouped by 20 gram intervals; the mean values for each season are indicated by arrows.

(Scheffer, 1938; Bond, *op. cit.*) on different species of *Thomomys* in southern California support the view that winter and vernal peaks are more or less distinctly separated by lower levels of breeding in midwinter. The degree of blending, if any, between winter and spring breeding seasons may depend on environmental conditions during the intervening period, a point to be considered later at greater length.

A schedule of pregnancies throughout the year is indicated by the seasonal weight distribution of pregnant females (fig. 2). In the spring, reproductive females of all sizes apparently breed. Body weights of pregnant females then range and are distributed more or less "normally" between 88 and 182 grams,

a wider range than in any other season. The summer breeding peak in 1944 was produced mainly by small-sized females which probably were born in the preceding spring and were reproducing for the first time. This is possible, theoretically, since available evidence indicates that female pocket gophers require only about three months to reach sexual maturity. Four of the 22 pregnant females in summer were less than 100 grams in weight, and 11 were less than 120 grams. The mean weight for pregnant females in summer (119.5 ± 4.05 grams) is significantly less by nearly 20 grams than that for any other season, and about 14 grams less than the average for all pregnant females (133.1 ± 1.68 grams). Large females, above average in weight, constitute but a small fraction of summer breeders and may be regarded as more or less incidental. In autumn and winter, larger-sized females reproduced—probably those that skipped the summer breeding season.

With the exceptions noted, breeding in previous years (1932-1941) was similar to that observed in 1944–1945. Pregnant or post-partum females were taken in the eight months represented in the earlier collections with the peaks in fertility showing during spring and winter. Data for the months from July to October are not available for years prior to 1944; hence the summer peak and low breeding in autumn observed in that year cannot be confirmed by the earlier records.

Summary.—The annual reproductive cycle of *Thomomys bottae navus* on irrigated lands at Davis, California, is characterized by year-long breeding with three seasons of markedly increased fertility. In order of importance, breeding peaks occur in early spring, summer, and early winter. Spring is the main breeding season, reproduction then being of longer duration and greater intensity than in the other seasons. Mature females of all sizes breed during spring; some more than once. The summer breeding season is relatively short but fairly intense. Summer breeding females are significantly smaller than average, possibly being animals born in the preceding spring. Little breeding occurs in the fall. The winter breeding season is variable, relatively minor, and may merge at times with the vernal season.

2. *Ovarian cycles.*—Potentially continuous breeding with three periods of increased reproductive activity is indicated in the ovarian analysis (Table 2 and fig. 3). Peak periods in ovulation occur in (1) December-January-February, (2) June, and (3) October. During these periods over 40 percent of the females show definitive follicles in the ovaries. These three periods undoubtedly represent mating seasons since heat presumably coincides with ovulation, and since they precede the previously demonstrated peak periods in fertility. In natural sequence, peaks in follicle production in the population are followed by periods in which there are progressively increasing percentages of females with corpora lutea, with corpora albicans (regressing corpora lutea), and with "clear" ovaries. If pregnancy ensues, the corpora lutea do not regress but remain through most of the gestation period as corpora lutea of pregnancy. Peak breeding periods are indicated by large percentages of females with such corpora in the ovaries. Thus, the female population may be said to undergo estrus cycles which, as in individual females, should bear a direct relationship to reproductive performance.

A general correspondence between trends in ovulation and subsequent fertility is apparent (fig. 6). High periods in ovulation are usually followed by peaks in

TABLE 2.—*Ovarian cycles in Thomomys bottae navus on cultivated (irrigated) land at Davis, California, 1944–45*

MONTH	NUMBER EXAMINED	PERCENTAGES ± S. E. OF ADULT FEMALES SHOWING:				
		Definitive follicles	Corpora lutea	C. lutea of pregnancy	Corpora albicans	"Clear" ovaries
1944						
April	17	0	12 ± 8	35 ± 12	0	53 ± 12
May	17	12 ± 8	35 ± 12	6 ± 6	24 ± 10	24 ± 10
June	39	41 ± 8	20 ± 6	5 ± 4	23 ± 7	10 ± 5
July	34	18 ± 7	26 ± 8	32 ± 8	9 ± 5	12 ± 6
Aug	29	17 ± 7	24 ± 8	10 ± 6	24 ± 8	24 ± 8
Sept	33	9 ± 5	15 ± 6	0	39 ± 8	33 ± 8
Oct	44	48 ± 8	16 ± 6	9 ± 4	14 ± 5	14 ± 5
Nov	33	15 ± 6	39 ± 8	0	18 ± 7	27 ± 8
Dec	26	42 ± 10	19 ± 8	8 ± 5	12 ± 6	19 ± 8
1945						
Jan	42	48 ± 8	17 ± 6	5 ± 3	7 ± 4	24 ± 7
Feb	33	39 ± 8	15 ± 6	24 ± 8	15 ± 6	6 ± 4
March	31	33 ± 8	32 ± 8	29 ± 8	10 ± 5	6 ± 4
April	18	11 ± 7	44 ± 12	11 ± 7	17 ± 9	17 ± 9
May	20	40 ± 11	10 ± 7	15 ± 8	10 ± 7	25 ± 10

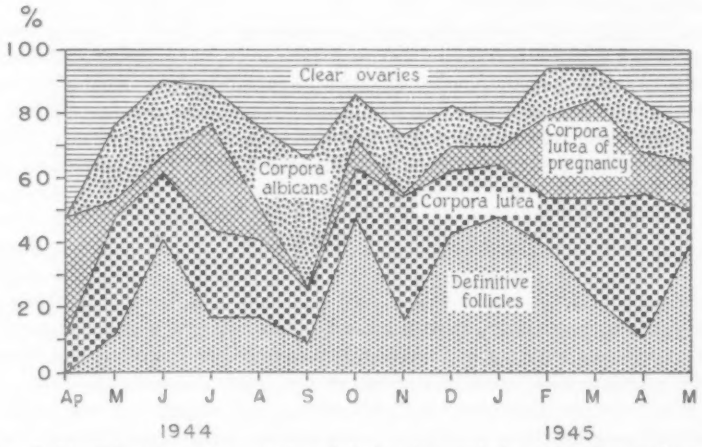

FIG. 3. Monthly composition of the adult female population of pocket gophers with respect to ovarian condition. Continuous ovulation with three annual peak periods in intensity of follicle production correlates with actual breeding (see fig. 1).

incidence of pregnant and post-partum females, while low periods of ovulation are precursors of low reproductive activity. For example, the June 1944 peak in

ovulation was clearly the harbinger of a correspondingly high percentage of pregnancy in July, whereas low fertility in the autumn of that year was forecast by a preceding lull in ovulation.

The correspondence between intensity of ovulation, which represents reproductive capacity, and subsequent reproductive performance in the population varies considerably through the year. In several months, percentages of pregnancy approximated those for ovulation in preceding months, indicating that reproductive performance measured up nicely at these times to reproductive potential. At other times, however, notably after peak ovulation periods in fall and spring, actual breeding fell far short of expectation. In general, ovulation exceeds fertility; this may be due in part to differentially low estimates of the latter. Nevertheless, gross failures on the part of gophers to breed up to potential may result from adverse environmental conditions. It is assumed here that the estrus cycle expresses the basic reproductive pattern of the species and is probably less affected by extrinsic factors than later stages in the reproductive sequence. When environmental conditions are conducive to breeding, the inherent reproductive potential may be approached or realized, but if unfavorable conditions prevail, breeding may fall far short of capacity. Environmental factors in relation to breeding will be considered more fully in the last section of this paper.

Summary.—Ovulating females were found in every month of the year, indicating potentially continuous breeding, but they were especially abundant at three periods which represent mating seasons. Peak periods of ovulation occur in (1) December-January-February, (2) June, and (3) October. They precede periods of high fertility, thus substantiating the existence of three breeding seasons.

There is a general correlation between trends in ovulation and subsequent fertility in gopher populations. Correspondence between intensity of ovulation (breeding capacity) and breeding performance varies considerably through the year, with occasional gross failures to breed up to expectation based on ovulation. The latter may be due to adverse environmental conditions at breeding time.

3. *Morphological indicators of breeding in the male.*—Position and size of testes have been used as the most important criteria of breeding in the male. According to Hill (*op. cit.*), testes in the pocket gopher enlarge during the breeding season and pass into the poorly-developed scrotum through large patent inguinal canals, as happens in many other mammals. As an extreme example in a rodent, the testes of the giant rat-headed hamster enlarge enormously in the breeding season, sometimes to one-fifth the size of the body (Loukashkin, 1944). An increase in percentages of males with scrotal and enlarged testes would be expected during breeding, or rather, mating seasons, while smaller and abdominal testes should prevail at other times. Data on position and size of testes in relation to breeding are considered separately in the following discussion.

(a) *Position of testes in relation to breeding.* Testes in the pocket gopher may occupy one of three positions—abdominal, scrotal, or inguinal (in the canal). Both generally occupy the same position, but males have been taken in which one

testis lay in a different position from the other. All three possible combinations of "mixed" positions have been found.

Descent may occur at an early age since scrotal testes were found in males weighing as little as 47 grams and a considerable percentage of juveniles were taken with scrotal testes (53 of 82 in 1944–45, and 10 of 67 in previous years). These records are in every month except October (when only one juvenile was taken, with inguinal testes) but the numbers are too small to ascertain cyclical trends, if any, in their frequencies. The proportion of juveniles with scrotal testes increases with size (age), thus showing some relationship between position of testes and sexual maturity. Testes in presumably immature males frequently are scrotal, indicating that *position* alone is not necessarily a sign of breeding.

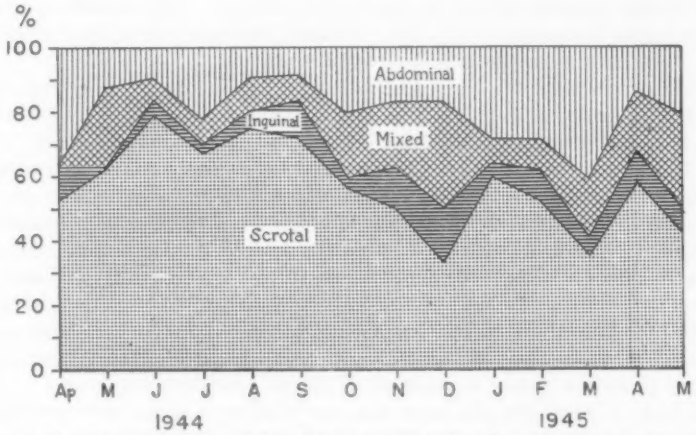

FIG. 4. Monthly composition of the adult male population of pocket gophers with respect to position of the testes. The cyclical changes in proportion of males with scrotal testes bear little relation to the breeding cycles exhibited by females (see figs. 1 and 3).

Cyclical changes in position of adult testes through the year are evident (fig. 4). The major cycle features high percentages of scrotal testes in summer and of abdominal testes in winter. In 1944–45, percentages of scrotal testes in adult males ranged from 79.1 percent in June to 33.3 percent in December. In January and February of 1945, there was a sporadic increase in scrotal testes (reaching 60 percent in January), but this peak was not apparent in previous years. Otherwise, the cycles in earlier years were essentially as in 1944–45. Percentages of adults with abdominal testes follow a trend reciprocal to that of scrotal testes. Males with inguinal testes and those with testes in mixed positions vary from about 10 to 20 percent, except in the period from October through December, when the frequency of such cases increased progressively to 45 percent.

The observed trends in position seem more closely related to seasonal conditions than to breeding cycles. The occurrence of adults with scrotal testes in

each month of the year is consistent with the concept of continuous breeding, but major changes in the proportions of such males do not always signify corresponding changes in intensity of breeding, and there are important discrepancies. Thus, while increased frequencies of scrotal testes early in 1945 and in June 1944 were possible precursors of increased pregnancy in subsequent months, the high percentages of scrotal testes in late summer and early fall are not consistent with the low level of breeding at that time. On the other hand, the annual temperature cycle and the proportion of males with scrotal testes seem closely associated. Expressing this relationship quantitatively, the coefficient of correlation between monthly percentages of scrotal testes and mean monthly soil temperature (one foot depth, about median for burrows) is 0.80 ± 0.10 for 1944–45 data despite the above-mentioned discrepancy in January and February when percentages of scrotal testes were high but soil temperatures were low. This correlation would be even higher if data for all years were combined, since low percentages for scrotal testes occur in these two months in previous years.

Correlation between two variables does not necessarily imply a causal relationship, but it seems unlikely that the above-demonstrated association between position of testes and environmental temperature is purely coincidence. Yet there is no ready explanation. The position of the testes in mammals is associated with body temperature; the lower temperatures prevailing in the scrotum are presumed to be essential to proper development of functional spermatozoa; and descent of the testes into the scrotum is a device to circumvent the possible sterilizing effects of higher abdominal temperatures (Moore, 1926). If and how external temperature affects the internal mechanisms here involved, and whether the effect of temperature on position of testes is direct or indirect (through other seasonable variables) are open questions. The relationship of testes position to breeding in pocket gopher populations is obscure, whatever the reason.

The lack of close correspondence between position of testes and breeding is probably associated in part with their early descent and easy passage from one position to another. The latter may be an adaptation to maneuvering in narrow burrows.

(b) *Size of testes in relation to breeding.* Before size of testes can be used as a reliable indicator of breeding in pocket gopher populations, it must first be established that significant seasonal changes in testes size occur that can definitely be correlated with known breeding performance.

Length of testes (with epididymis removed) was used as an index of size since not enough weight measurements were available. Length and weight of testes, however, are closely correlated ($r = 0.87 \pm 0.01$) so that length is an adequate estimate of size. Preliminary analyses also demonstrated that length of testes is practically a linear function of body weight of the animal; that the testes in each position lengthen with increase in body weight; and that in males of comparable weights no consistent or significant differences are found in mean lengths of testes in scrotal, abdominal, or other positions. Since mean weights of samples of adult males in several months deviated rather widely from the yearly average, it was necessary to adopt procedures to eliminate the effect of body weight on size

of testes. Otherwise, periodic changes in size of testes might be attributed erroneously to breeding condition, whereas actually they might be due to fluctuations in weight of the males in the sample. Consequently, relative rather than absolute lengths were used. "Relative lengths" of testes were obtained by dividing the lengths of testes (in mm. × 100) by the body weight (in grams) for each male; the values so obtained represent the length of testes in relation to body size. Thus, the mean relative lengths of testes are independent of the weights of males in a sample.

Marked cyclical changes in mean relative testes lengths, regardless of the position of testes are seen in the 1944–45 male population (fig. 5). Scrotal

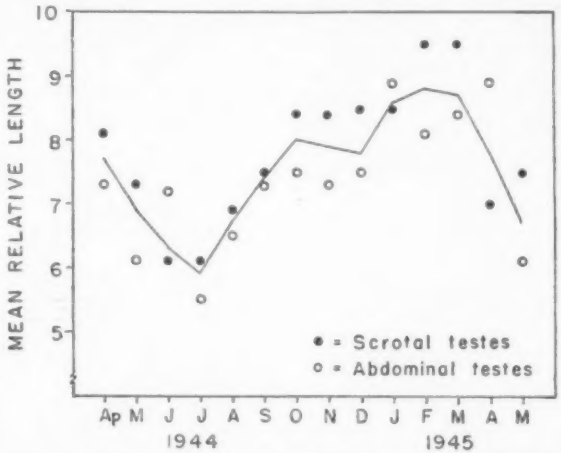

FIG. 5. Annual cycles in relative length of the testes in adult male pocket gophers. Filled circles represent monthly means for scrotal testes and clear circles those for abdominal testes; the trend line is drawn through monthly means for testes in all positions (scrotal, abdominal, inguinal, and mixed).

testes average relatively small in June and July, but increase rapidly in length through August and September to a high plateau maintained through the next four months, and finally reach a peak of enlargement in February and March. A marked decline occurs thereafter leading to the small sizes prevalent during summer. The maximum monthly mean for relative length of scrotal testes in 1944–45 was 9.5 (February and March), an increase of 56 percent over the minimum of 6.1 (June and July), or about 22 percent above the yearly norm of 7.8 (unweighted monthly average). Seasonal trends in absolute lengths of scrotal testes parallel those exhibited by relative lengths (since average body weights of adult males are fairly uniform month to month) and the oscillations about the yearly norm are of the same order of magnitude.

Seasonal trends in relative size of adult testes in the several positions and in juveniles are also shown (Table 3). Both abdominal and scrotal testes, in rela-

tion to body size, average large in winter, small in summer, and medium in spring and fall. The testes of juveniles show somewhat the same size cycle as in adults, being relatively small in spring and summer, larger in fall and winter. Testes in both adults and juveniles show parallel and statistically significant changes in relative size with season which casts doubt on the reliability of testes size as an indicator of breeding in pocket gopher populations. It should be noted, however, that adult testes average relatively longer than juvenile testes in every season (except fall) which indicates that testes do undergo relative enlargement with maturity.

Scrotal testes in adults tend to be relatively larger than abdominal testes in each season, but the differences are slight and not statistically significant, except in the fall. If size has any reference to breeding, then the lack of significant size differences between scrotal and abdominal testes is further evidence that position of the testes is a poor indicator of breeding.

The relation of the observed changes in testes size to breeding is not precise although there is some correspondence. The peak period of enlargement

TABLE 3.—*Seasonal trends in relative size of testes in Thomomys bottae navus*

1944–45 SEASON	MEAN RELATIVE LENGTHS OF TESTES ± S. E.			
	Adults			Juveniles
	Scrotal	Abdominal	All positions[1]	All positions
Spring	7.7 ± 0.39	7.5 ± 0.50	7.5 ± 0.27	6.0 ± 0.31
Summer	6.3 ± 0.47	6.0 ± 0.66	6.3 ± 0.22	5.7 ± 0.47
Fall	7.9 ± 0.20	6.3 ± 0.54	7.7 ± 0.19	7.9 ± 0.57
Winter	8.8 ± 0.36	8.4 ± 0.44	8.5 ± 0.23	7.5 ± 0.54
Year	7.4 ± 0.30	7.1 ± 0.58	7.4 ± 0.12	6.5 ± 0.24

[1] This category comprises testes in scrotal, abdominal, inguinal, and mixed positions.

observed in February and March coincided with the vernal breeding season, and enlargement of testes in late fall may be associated with winter breeding. The relatively small scrotal testes prior to and during the summer breeding season and large ones in early fall, a low breeding season, are unexplainable, however, and this fact casts further doubt on the reliability of testes size as a breeding indicator in pocket gophers.

As in the case of testes position, there is a close association between size of testes and soil temperature, but here the correlation is inverse ($r = -0.85 \pm 0.04$, for all positions). Thus, as temperature decreases, testes become relatively larger and *vice versa*. In the hot summer, testes tend to be relatively small and scrotal in position, becoming relatively larger and more abdominal in winter. How these seasonal effects are brought about is not known. Histological studies may furnish an explanation. In any event, the seasonal effects dominate and obscure the relationship of testes size to breeding.

Summary.—Cyclical changes both in size and position of testes are demonstrated that seem more closely related to seasonal conditions (notably the annual

temperature cycle) than to breeding. Adult testes tend to be relatively small and scrotal in position in summer, significantly larger and abdominal in winter, and transitional in these respects during spring and fall. Descent of the testes may occur early in life, and they are frequently scrotal in juveniles. Although relatively smaller on the average than those of adults, testes of juveniles also undergo seasonal changes in relative size, being significantly smaller in spring and summer than in fall and winter. The sum of evidence is that gross characters such as size and position of testes cannot be used to assess or predict reproductive performance in pocket gopher populations.

4. *Other evidence of breeding.*—(a) *Juvenile incidence.* Supplementary and confirmatory evidence on breeding may be had from other sources. For example, the age composition of the population, particularly the incidence of juveniles may furnish valuable clues. As would be expected with year-long breeding, a continuous stream of juveniles contributes to the monthly samples, but their relative frequency increases after peak fertility periods. Since pocket gophers are weaned at 35 to 37 days (Sagal, *op. cit.*, and doubtless disperse or become active in the maternal burrow system soon afterward, juveniles should first appear in the collections about five weeks after birth. The smallest gophers captured are about the size atttained at weaning age.

There are three peak periods in the incidence of gophers less than 80 grams in body weight (small juveniles) (fig. 6). These peaks confirm the existence of three main breeding seasons since they follow the latter by about two months, as would be expected. Especially in the months of April, May, and June there is a great influx of juveniles resulting from early spring breeding. In May 1945, 32 of the 76 gophers taken were juveniles. A marked increase in numbers of small gophers was noted in September following the breeding peak in July. An increase in small juveniles in December substantiates the suspicion of considerable breeding in late fall or early winter.

(b) *Plural catches.* Records of more than one gopher to a system are too few to be particularly instructive as indicators of seasonal breeding activity. Of 13 dual catches in 1944–45, five are male and female in presumed mating condition (females ovulating, males with enlarged scrotal or, in one case, inguinal testes). Three mating pairs were taken in October confirming other evidence of suspected breeding in that month; the other two couples were trapped in February and May. The remaining eight cases include various combinations: males with pregnant females (two cases, in July); male with post-partum female (in May); male with juvenile female that weighed 45 grams (in May); females with juveniles (three cases, all in December); and two adult females together, one post-partum (in August). The December records of females with juveniles are further confirmation of breeding in late fall. Males may remain in burrows with females for some time after mating as suggested by instances of males found with pregnant and recently pregnant females and with juveniles.

Summary.—Records on juveniles and of plural catches (more than one gopher per burrow system) substantiate, or at least are consistent with, the conclusion

that pocket gophers breed continuously with three heavy breeding seasons in early spring, summer, and early winter.

5. *Number of broods.*—Direct evidence on the number of broods a female may have in a year or in her reproductive lifetime is lacking, but inferences may be drawn from analysis of collection data. Since age, diet, and other factors cause variation in fertility, estimates of the annual number of broods can only be approximate and must be stated in terms of the "average female".

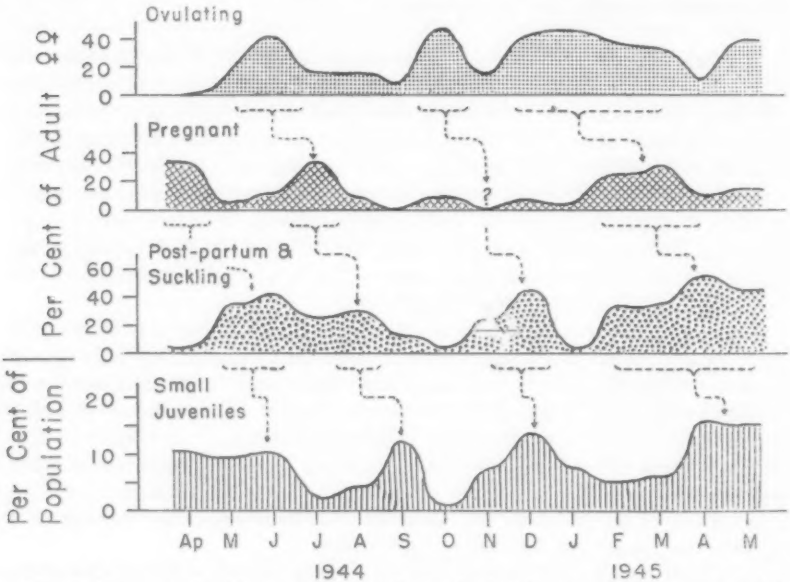

FIG. 6. Summary of evidence on reproductive cycles in *Thomomys bottae navus* on cultivated (irrigated) lands at Davis, California, showing year-long breeding with peak periods in the spring, summer, and winter. Broken lines connecting the peaks represent the probable sequence of events. The absence of pregnant females in November of 1944 is attributed to a sampling error (see p. 340).

Scheffer (1933, 1938) uses a statistical method for estimating the number of broods per female over any period of time. By totaling the percentages of pregnancy for samples collected at time intervals that correspond to the gestation period, he obtains a value which (divided by 100) is the "number-of-broods factor". Theoretically, if this summation of pregnancy percentages exceeds unity (100 percent), it means that some females had more than one litter during the period studied. Assuming a gestation period of one lunar month for pocket gophers, Scheffer obtained a number-of-broods factor of 2.8 for *Thomomys bottae (pallescens?)* over a nine month period (October to June) at El Monte, California, and of 2.35 for *T. bottae albatus* at El Centro. Females of these two races thus

averaged between two and three litters in nine months. As Scheffer points out, these values are corrected for juveniles, but not for adult females themselves born within the period investigated. Exclusion of the latter would affect the number-of-broods factor only insofar as the percentage or onset of pregnancy in these differs from that of other adults. The values are not corrected for old adults who no longer participate in the reproductive program.

With slight modification, Scheffer's method may be applied to the 1944–1945 data. Determination of the percentage of pregnancy from data *grouped* at intervals corresponding to the gestation period is equivalent to his procedure of calculating pregnancy from samples trapped at such intervals. Taking his estimate of one lunar month as the gestation period, an annual number-of-broods factor of 1.94 (April 1, 1944 to March 31, 1945) or of 1.77 (June 1, 1944 to May 30, 1945) is obtained. Corresponding values are 1.76 and 1.61 on a calendar month basis. In brief, about two litters a year is maximum for adult females of *Thomomys bottae navus* according to this method of reckoning.

Estimate of pregnancy based on collection records and number-of-broods factors calculated therefrom undoubtedly are too low. As pregnancy advances, pregnant females probably are more secluded, perhaps more wary, and progressively less likely to be caught. Of 145 pregnant females, the numbers with small, medium, and large embryos were 81, 43, and 21, respectively. This inequality represents an appreciable reduction in frequency of take of females in late pregnancy with consequent reduction in percentages of pregnancy as determined from field samples. Moreover, many very early pregnancies probably escape detection in post-mortem examinations which further reduces pregnancy estimates. Corrected pregnancy percentages would raise the number-of-broods factor to a value betwen two and three per year which is more logical in view of the three high breeding seasons already demonstrated.

Number of broods may be calculated from other estimates of fertility. Summation of monthly percentages of post-partum females, an alternate estimate of actual fertility, gives an annual broods-factor of 1.54 (April 1, 1944–March 31, 1945) or 2.16 (June 1, 1944–May 30, 1945). On a lunar month basis, the corresponding values are 1.89 and 2.45 broods per year. These values are higher than those obtained from pregnancy data and are probably nearer the true value for annual number of broods.

Potentially, females are capable of greater reproductive performance than they exhibit, as has already been suggested, and as shown by the following calculations. Summation of monthly percentages of ovulating females yields annual broods estimates of 3.22 or 3.61 depending on the yearly period selected. On a lunar month basis, these values would be somewhat higher.

Summary.—The average adult female is capable of producing more than three broods per year, but estimates of actual production range between 1.5 and 2.5 litters per year, or an average of 2.0.

6. *Number of young.*—Size of broods may be indirectly and variously estimated from counts of embryos or embryo sites in the uterus. Since considerable

resorption of embryos may occur (Table 5), the number of embryos does not necessarily indicate the number of young that will be born. The latter should be estimated from counts of fetuses shortly before termination of pregnancy, or of fetal sites thereafter. The degree of resorption may be determined by estimating reductions in litter size with advance in pregnancy (Table 4).

The data show an average decrease of roughly half an individual per litter during gestation or about 8 percent reduction in litter size; this is not statistically significant, but might be so with a larger number of cases. Observational evidence (in 7 of 145 pregnancies), however, leaves no doubt that fetal death and resorption does occur, and in individual cases may eliminate half of a litter

TABLE 4.—*Size of litters in Thomomys bottae navus*

STAGE OF PREGNANCY	NUMBER OF FEMALES	NUMBER OF EMBRYOS OR FETAL SITES PER LITTER	
		Range	Mean ± S. E.
Embryos:			
small	81	2–13	5.77 ± 0.21
medium	43	1–10	5.23 ± 0.27
large	21	1–9	5.39 ± 0.39
all sizes	145	1–13	5.55 ± 0.15
Fetal sites (post-partum)	110	1–9	4.92 ± 0.15

TABLE 5.—*Records on resorption of embryos in Thomomys bottae navus*

DATE EXAMINED	WEIGHT OF FEMALE (GRAMS)	EMBRYOS OR FETUSES			
		Number in litter	Length (mm)	Resorbing	
				Number	Percentage
3–17–32	146	6	26	?*	?
3–25–32	150	8	11	1 (?)	12.5
3–30–32	167	6	23	3	50.0
4– 2–32	130	3	5	1 (?)	33.3
11–20–35	—	5	–	2	40.0
10–10–44	150	4	12–13	1	25.0
2–10–45	133	4	7–8	2	25.0

* Number not stated, probably 2 or 3.

(Table 5). All but two cases of resorption occurred during early spring and all were in females of average size or larger—facts which may be significant.

The mean number of fetal sites is significantly less than the mean for small or for all sizes of embryos (differences of 0.85 ± .26 and 0.63 ± .21, respectively), but the differences between means for fetal sites and medium or large-sized embryos are not statistically significant. The decrease may be due in part to earlier disappearance of some sites resulting in lower counts, but the greater part is probably explainable on the assumption of fetal death and resorption of part of the litters. Dead fetuses in early stages of resorption are probably counted as normal at times and hence the mean number of offspring based on counts of embryos tends to be overestimated. It is highly probable, however, that the

mean number of offspring per litter lies between 4.92 and 5.39 (means for post-partum fetal sites and for large embryos, respectively).

7. *Rate of increase.*—The net rate of increase in a population depends on the balance of birth and death rates or, as Chapman (1931) puts it, on the relation between "biotic potential" and "environmental resistance". Biotic potential, as he defines it, includes not only "reproductive potential" (births) but also "survival potential" which operates throughout life; each may be further subdivided. Environmental resistance is also the resultant of various partial factors, and is indicated by the ratio of numbers of individuals actually existing at any time to the numbers that might have existed. Attempts to express all these factors quantitatively for pocket gophers would be premature, but gross rates of increase may be fairly estimated from available data.

Rate of increase may be expressed in several ways. In terms of young per adult female, it is the product of number of broods and number of young per litter. From ecological and practical standpoints, however, it is sometimes desirable to state the rate of increase in terms of young per unit of population,

TABLE 6.—*Annual gross rate of increase in Thomomys bottae navus*

ESTIMATES	LITTERS PER ADULT ♀	YOUNG PER LITTER	YOUNG PER ADULT ♀	COEFFICIENT OF BIRTH*
Minimal	1.54	4.92	7.6	3.0
Maximal	2.45	5.77	14.1	5.7
"Average"	2.00	5.34	10.7	4.3

* Young per unit of population, assuming that 40 percent of the population are reproductive females.

a value obtained by multiplying the number of young per adult female by the "effective sex ratio" (proportion of reproductive females in the population). This product, the "coefficient of birth" (Volterra, in Chapman, 1931), is useful in studies of population dynamics.

Annual rates of increase (gross) for *Thomomys bottae navus* and factors involved in calculating them are given in Table 6. The average adult female is estimated to produce nearly 11 young per year. Gross population increases can be estimated by multiplying the number of individuals in a given population by the coefficient of birth (number of young per unit of population). The latter, however, is difficult to determine accurately since it is the product of two variables—the proportion of reproductive females and the number of young per adult female. Adult females constituted 40 percent of the collection, but this value probably is somewhat higher than the effective sex ratio in the field since small non-reproductive individuals are not represented in trap collections. If 40 percent is taken as an estimate (probably maximal) of the effective sex ratio, however, then the coefficient of birth lies between 3.0 and 5.7 with an average of 4.3. Thus, if there are 30 gophers in a field and no deaths or migrations (in or out) occur, at the end of a year there would be between 90 and 171 gophers in addition to the original population, with 129 as an average estimate. These values represent the

numbers of gophers that must die, be killed, or emigrate each year if the population in that field is to remain constant.

Net rates of increase can be calculated when mortality rates are known. The latter are difficult to determine for a wild species; they may fluctuate widely, possibly cyclically, and their estimation is beyond the scope of this paper.

Summary.—The annual number of young per adult female pocket gopher on cultivated land in the vicinity of Davis, California, is estimated at between 7.6 and 14.1 with 10.7 as an average. Estimates of yearly increase per unit of population range between 3.0 and 5.7 with 4.3 as an average.

8. *Factors affecting breeding.*—The basic reproductive pattern of a species is regarded as relatively stable and genetically determined. Ovarian cycles, span of reproductive life, average number of broods and of young per litter are fairly constant for a species (King, *op. cit.*). Actual fertility, however, may be influenced by various intrinsic and extrinsic factors whose individual roles are difficult or impossible to segregate. Incidental to this investigation, information was

TABLE 7.—*Fertility in Thomomys bottae navus in relation to size of female*

WEIGHT CLASSES (GRAMS)	NUMBER OF FEMALES EXAMINED	FREQUENCY OF LITTERING		EMBRYOS PER LITTER MEAN ± S. E.	AVERAGE NUMBER OF YOUNG PER YEAR
		Percentage of pregnancy ± S. E.	Number of broods per year		
<80	132	0	0	0	0
80–99	239	3.3 ± 1.2	0.6	4.4 ± 0.6	2.6
100–119	359	8.4 ± 1.5	1.0	4.8 ± 0.2	4.7
120–139	328	14.9 ± 2.0	2.0	5.3 ± 0.3	10.6
140–159	138	33.3 ± 4.0	2.4	6.0 ± 0.3	14.4
160–179	30	36.7 ± 8.8	2.3	5.8 ± 0.7	13.3
180–199	5	20.0 ± 17.9	?	8	?

obtained on some constitutional and environmental factors that influence fertility in pocket gophers.

(a) *Constitutional factors.* Age of female is a primary factor regulating fertility. As shown in Table 7, frequency of breeding and size of litters increases with size (age) of females to an optimum after which there is indication of a decline in fertility. The possibility of an upper age limit beyond which fertility ceases (menopause?) is suggested by the absence of pregnancies in females weighing over 182 grams, but such cases are few. These data are in accord with the findings of King (*op. cit.*) in several strains of Norway rats. Females of *Thomomys bottae navus* reach optimum breeding size at about 140 grams. A population of gophers with females of about this size would be several times more prolific than one in which small females predominate.

(b) *Environmental factors.* External factors affecting breeding may be deduced through analysis of seasonal differences in fertility and by comparison of breeding under different environmental conditions in the same season.

Seasonal differences in fertility are summarized in Table 8. As previously stated, reproduction in summer is mainly by smaller (younger) females, probably those born in the preceding spring and just attaining sexual maturity. This

inference is supported further by the fact that litter sizes are significantly smaller in summer than in any other season as might be expected from the demonstrated association of litter size and weight of female. The fact that small-sized females in other seasons also bear small litters rules out any seasonal environmental influence reducing litter size in summer.

Because of the longer duration and greater intensity of vernal breeding, the rate of increase in spring is nearly as great as for all other seasons combined. According to many authors, breeding cycles have evolved in such a way that the young born at times most favorable for survival of mother and offspring. In many other species of mammals, spring is the principal or sole breeding season.

TABLE 8.—*Seasonal differences in fertility in Thomomys bottae navus*

	SEASON				
	Spring (March–May)	Summer (June–Aug.)	Fall (Sept.–Nov.)	Winter (Dec.–Feb.)	Year
Young per litter	5.8–5.1*	4.4–4.0	5.5–4.0	5.8–5.3	5.6–4.9
No. broods† per season	0.6–0.8	0.6–0.3	0.1–0.2	0.4–0.4	1.7–1.6
Young per adult female	3.5–4.1	2.6–1.2	0.6–0.8	2.3–2.1	9.5–7.8

* The first values given throughout the table are based on pregnant females, the second on post-partum females.

† A gestation period of one calendar month was assumed in calculating the number-of-broods factor.

TABLE 9.—*Comparison of breeding of pocket gophers in alfalfa and other fields during spring and summer, 1944–45, at Davis, California*

PERIOD	HABITAT	NO. OF ADULT ♀♀ COLLECTED	PERCENTAGES ± S. E.		
			Pregnant	Post-partum	Pregnant plus post-partum
March–May	Alfalfa fields	64	17 ± 4.7	34 ± 5.9	52 ± 6.2
	Non-alfalfa fields	40	25 ± 6.8	28 ± 7.1	52 ± 7.9
June–July	Alfalfa fields	62	27 ± 5.7	10 ± 3.8	37 ± 6.1
	Non-alfalfa fields	15	0	13 ± 8.7	13 ± 8.7

An ecological inference, therefore, is that conditions then are more favorable for breeding than at other seasons, and that estrus cycles, mating instincts, and gestation period are adapted accordingly. In California, especially in the central valleys, natural conditions presumably favoring breeding of gophers are (1) abundance of available green food resulting from winter and spring rains, (2) moderate temperatures, and (3) tractable moist soil for burrowing and construction of underground nests. During the long rainless season, irrigation should prolong the essential conditions. Comparisons of breeding intensity in gophers living in irrigated land and in dry fields is therefore pertinent.

Comparable data on breeding of gophers in alfalfa and in other fields are given in Table 9. In spring, there was no significant difference in the breeding of

gophers in these fields. In fact, the percentage of pregnant females then was slightly higher (but not significantly so) in non-alfalfa fields. In summer, however, when green forage was available only in irrigated fields, the percentage of pregnant and recently-pregnant females was significantly greater than in non-irrigated fields, the difference in fertility being 24 ± 11 percent. The difference is even more striking when only pregnancies are compared, 27 percent in irrigated and zero in other fields.

These findings strongly indicate a nutritional factor in breeding, probably a vitamin. An antisterility vitamin, discovered by Evans and Bishop (1922) and subsequently designated vitamin E, is found importantly in green leaves (such as alfalfa) and in wheat germ oil and other vegetable fats. Deficiency of vitamin E in female rats results in fetal death and resorption, but does not affect estrus, ovulation, or fertilization. In males, irreparable sterility may result through degeneration of germinal epithelium. Other dietary deficiencies may have indirect, less drastic effects on reproduction. Quite possibly, therefore, lack of fertility factors in the available diet of pocket gophers may account for their failure to breed on dry forage or in the wild during the hot dry season. It may account in part for the reported occasional failures to measure up to potential reproductive capacity. Additional data are needed to clarify the role of nutritional factors in the breeding of pocket gophers.

SUMMARY

1. On cultivated (irrigated) lands in the Sacramento Valley, California, pocket gophers may breed continuously, with three periods of increased fertility (breeding seasons) in spring, summer, and early winter. Year-long breeding is shown by the occurrence of ovulating, pregnant, post-partum, and suckling females, and of small recently-weaned juveniles in every season. Three marked breeding seasons are demonstrated by peak periods in incidence of the above-named types of individuals following each other in natural sequence.

2. The main breeding season is in spring, reproduction then being of longer duration and greater intensity than at other times of year. Summer breeding is mainly by small-sized (young) females, possibly those born in the preceding spring. Little breeding occurs during the autumn. The winter breeding season is variable and in some years may merge with the vernal season.

3. Seasonal cycles in the length and position of the testes seem more closely associated with environmental conditions (particularly temperature) than with the breeding cycles of females. In adults, the testes tend to be shorter and scrotal in position in summer, longer and abdominal in winter, and transitional in both respects during spring and fall. Descent of the testes may occur early in life, and they are frequently scrotal in juvenile gophers. Although averaging relatively smaller, juvenile testes undergo seasonal size changes paralleling those of adults. Hence, gross characteristics of males such as size and position of the testes, which generally are regarded as good signs of breeding, are not in themselves reliable indicators of reproductive trends in pocket gopher populations.

4. The average adult female is potentially capable of producing more than

three broods per year as determined by intensity of ovulation. Estimates of the annual number of broods, based on actual breeding performance, range between 1.5 and 2.5 per adult female.

5. The number of young per litter is estimated between 5.77 ± 0.21 (mean number of small embryos per female) and 4.92 ± 0.15 (mean number of fetal sites in post-partum females). The statistically significant decrease in numbers of embryos with advance in pregnancy is attributed to fetal death and resorption *in utero*.

6. Estimates of gross rates of increase in pocket gophers range between 7.6 and 14.1, with an average of 10.7 young per adult female per year.

7. Fertility in female pocket gophers increases with size (age), with some evidence of decline in the largest (older) females.

8. Breeding in alfalfa fields (irrigated during the dry months) is significantly greater in summer than in non-irrigated fields, but not so at other times of year. A nutritional factor influencing breeding in pocket gophers is suspected.

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ZOOLOGICAL SUBSPECIES OF MAN AT THE PEACE TABLE[1]

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Will the information accumulated by zoologists be used at the peace table now that the war is over? Many zoologists maintain that application of this information will lengthen the interval of peace and think that disregard of it will unnecessarily shorten the peace.

The systematic zoologist, one who classifies animals as to kind, has something to offer. If he specializes on the class Mammalia, it is clear to him as it is to the nonzoologist that man differs in heritable structure from place to place over the world's land area. Now the zoologist knows also that other species of mammals differ from place to place. In any one of these species, if the differences in shape and size are such that all individuals in one considerable area can be distinguished from all those in another, the kinds are classified as subspecies. In man, the races and geographic variants are divisible into approximately five zoological subspecies. The word approximately is used because some zoologists would include subspecies *americanus* under *asiaticus* and so recognize only four subspecies, whereas other zoologists would subdivide *asiaticus* into two or more

[1] A resolution was moved, seconded, and passed by the audience at the reading of scientific papers at the joint session of the annual convention of the American Society of Mammalogists and the American Society of Ichthyologists and Herpetologists in Pittsburgh, Pennsylvania, on April 18, 1946, "that this paper be published and that copies of it be sent to the United Nations' Representatives."

The above resolution was not made in an official business meeting of the Society, however, and, therefore, opinions expressed in this article, as in other articles published in the Journal of Mammalogy, are not necessarily those of the Society. *Ed.*

subspecies and thus would recognize more than five subspecies. The five subspecies here recognized are:

(1) *Homo sapiens sapiens*, Caucasian;
(2) *Homo sapiens americanus*, American Indian;
(3) *Homo sapiens asiaticus*, Mongolian;
(4) *Homo sapiens afer*, Negro;
(5) *Homo sapiens tasmanianus*, Australian Black.

Something that most nonzoologists seem not to know is that the subspecies of man are distinguished one from the other by the same sorts of differences—characters, in zoological parlance—as are subspecies of almost any other kind of mammal, say, subspecies of the mole, marmoset, or moose. For example, in the skull of a Point Barrow Eskimo, one of the races of the subspecies *Homo sapiens asiaticus*, the size and shape of the bony opening for the nose is significantly different from that in a Zulu Negro, one of the races of the subspecies *Homo sapiens afer*. In the Eskimo the opening is narrow (less than half as wide as high), whereas in the Negro it is wide—more than half as wide as high. Under a microscope the hair of the head of the Zulu is seen to have a characteristic shape in cross section, and inspection by means of only the naked eye reveals that the hair of the Zulu is kinky and his skin black, whereas the Eskimo's hair is straight and his skin reddish or dark yellow. Even cursory comparison will serve to multiply this list of differences. Similarly, in the moose, the subspecies *Alces alces alces* of Europe has the premaxillary bone extended back beneath the nasal bone and the color of its hair is grayish, whereas the subspecies *Alces alces gigas* from Alaska differs in that the premaxillary bone does not extend back so far as the nasal bone and the hair is blackish (see figure 1 showing geographic ranges of the subspecies of moose).

It is necessary thus to stress that subspecies of man, like subspecies of other mammals, are distinguished by trenchant morphological characters of a heritable sort, because many advocates of an international brotherhood of man give the impression that kinds of men cannot be so distinguished. This mistaken impression prevails probably because in an area geographically intermediate between those inhabited by two different subspecies, crossbreeding produces people with intermediate structural characteristics. This blending, or more precisely intergradation, makes it impossible certainly to classify as to subspecies every individual person. For example, in crossing Asia on the Trans-Siberian Railway, the passenger rides through a belt of transition in which the native peoples are intergrades between Orientals (subspecies *asiaticus*) and Caucasians (subspecies *sapiens*). As a result the anthropologist usually says something to this effect: Because of intergradation it is impossible satisfactorily to distinguish one race of man from another. Note that the anthropologist said one race—not one subspecies which is composed of several or many races—but, nevertheless, from this statement other persons (usually unfamiliar, to be sure, either with physical anthropology or zoological classification) conclude that it is impossible to distinguish by tangible structural characteristics all Eskimos from all Zulus as we

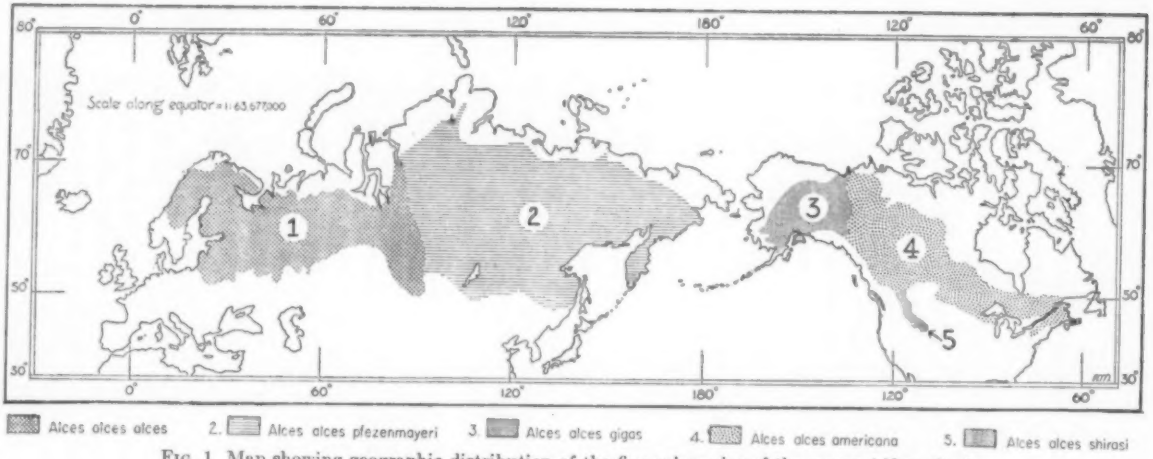

FIG. 1. Map showing geographic distribution of the five subspecies of the moose (*Alces alces*).

FIG. 2. Direction of migrations between Asia and North America of some of the larger land mammals in later geologic time.

have been at pains to show can be done. Incidentally, and most significantly, it is this intergradation which permits and requires the division of men into subspecies, because, for the systematic mammalogist intergradation is the criterion for subspecies and lack of intergradation is the criterion for species. Therefore, if there were no geographic intergradation (crossbreeding) in the areas where the geographic ranges of two kinds meet, they would be full species instead of subspecies.

The differences in customs, habits, and especially in artifacts which tend to set man apart from other mammals, have unquestionably complicated the geographic distribution of subspecies. For example, the construction and use of boats have given to the subspecies of man on the Pacific Islands a distribution different from that of almost any other terrestrial mammal. Still, the difference in artifacts and habits in different areas may have aided geographic differentiation and one effect probably offsets to some extent the other.

Not only do subspecies of man differ in shape of parts of the skeleton, color of skin, and shape of hair, as do subspecies of other kinds of mammals, but they differ in physiological characteristics. A Chinese who finds himself in a crowd of perspiring whitemen, or a Caucasian who finds himself in a similar situation among Negroes, by distinctive odor alone can identify his companions as of a subspecies different from the one to which he belongs. G. M. Stratton and P. M. Henry (Amer. Jour. Psychology, vol. 56, p. 169, 1943) record significant differences in electrical resistance of the skin of Caucasians and Orientals when there was involuntary impulse to avoid pain.

For these reasons the zoologist recognizes the falsity of statements to the effect that kinds of men cannot be satisfactorily distinguished morphologically or physiologically. He knows that subspecies can be satisfactorily distinguished and, as an improved basis for amicable relations between them, urges frank recognition of the differences, the better to make allowances for them.

Many persons who have expressed themselves on racial and international problems at the peace table in the past were unaware of the magnitude of these differences, therefore minimized their importance, and so far as known the zoologist's view has never been taken into account in drawing up peace terms. Recognition of the differences between subspecies of man, or for that matter recognition of inherent differences between categories of almost anything, permits the application more readily of provisions that promote harmony. Harmony among men makes for peace and thus we see one reason for the zoologists' contention that application of their findings may contribute to a longer enduring peace.

But the zoological view may be helpful in yet other respects. Consider, if you will, the results of competition between closely allied subspecies of wild mammals when one penetrates into or is introduced into the range of another. Whether they be mice, moles, or monkeys, one and only one subspecies survives in a given area, because after a few thousand years, ordinarily in a much shorter time, cross breeding may result in amalgamation, a sort of extinction by dilution. But the more common results are either that they fight and one kills the other, or that as a result of less direct combat, the individuals of one subspecies more

Fig. 2. Direction of migrations between Asia and North America of some of the larger land mammals in later geologic time.

often usurp the best food, places best suited for rearing young, and shelters affording maximum protection from enemies. Therefore the one subspecies thrives, whereas the other subspecies because of lower birth rate and decreased longevity that result from inferior food, inferior nurseries and insufficient shelter, decreases and disappears. The introduced black rat (*Rattus rattus rattus*) has disappeared from some large areas in North America where competition was furnished by another introduced subspecies, *Rattus rattus alexandrinus*. So it goes in almost every instance where kinds of mammals so closely related as subspecies of the same species are suddenly thrown into competition over a large area. Indeed, study of the thousands of subspecies of native wild mammals has led to the formulation of the biological law concerning them that: *Two subspecies of the same species do not occur in the same geographic area.* Of the half dozen or fewer exceptions reported to date, reinvestigation has shown that the two kinds instead were in every instance full species, or two subspecies that lived each in a habitat apart from the other. Thus the rule remains almost or quite without exception and it should give pause to anyone about to advocate the long continued residence together of subspecies of man.

Another zoological generalization that man ought to take into account is that when two kinds of closely related animals are thrown into competition, the one native to the larger land mass ordinarily prevails. The reported increase of the introduced Old World reindeer (*Rangifer tarandus tarandus*) in Alaska at the expense of the native caribou (*Rangifer tarandus arcticus*) is a case in point. The red-backed mouse (*Clethrionomys dawsoni*) which seems to be relatively a newcomer to the Alaskan area of North America from Asia, appears to be succeeding at the expense of the native American red-backed mouse (*Clethrionomys gapperi*). In past geological ages there have been several interchanges of fauna between North America and Asia. These were at times when a higher land level, or a lower sea level, between Asia and North America provided a land bridge between those two continents. Our increasingly complete record of fossil mammals shows that the balance in those past ages, as well as in the present, definitely favored the large land mass, Asia (see fig. 2). That is to say, of the mammals that North America gave to Asia in later geologic time, only the camels and horses survived there; but of the mammals that Asia gave to North America, elk, moose, reindeer, bison, and other species prevailed and remain in North America today.

What, then, are the chances of survival of the Caucasians in North America if they permit infiltration of the Oriental subspecies of man from the larger land mass of Asia? The Caucasians' chances would appear poor indeed. But the Caucasians aren't Americans—there isn't a family among them that can claim residence of more than 400 years on this continent; the Caucasians, too, are from the larger land mass, the Asiatic land mass, albeit from its western edge whereas the Orientals are from its eastern edge. What the Caucasian subspecies did to the subspecies native here, the American Indian, whose ancestors at a much earlier time came from Asia, the Caucasians may after all avoid for themselves because their recent Asiatic origin gives them in North America almost a 50–50 chance with the Orientals.

But, is this competition necessary? To invite it by permitting the immigration of Orientals, and to foster it by granting citizenship on the North American mainland to Orientals seems foolish and violates every biological law, of recent and past geological ages, that relates to the harmonious existence of two or more subspecies of the same species. To imagine one subspecies of man living together on equal terms for long with another subspecies is but wishful thinking and leads only to disaster and oblivion for one or the other. More to the point at the moment, such a course and its inescapable consequence insure in the process of solution either bloodshed and violence or a more insidious competition in which racial prejudice, and fancied superiority, set over against alleged inferiority, come to the surface with all of the associated evils that poison men's minds, sicken their bodies and torture their souls.

By joining in the struggle these last 5 years to subdue a race of the Caucasian subspecies (German) and a race of the Oriental subspecies (Japanese), each of which has proclaimed its racial superiority, Americans, in effect, dedicated themselves to the proposition that no one subspecies, much less any one race, shall constitute itself a jury, judge and high sheriff for all people of the world. The biologist knows that subspecific characters make Negroes extreme in hairlessness of body, Caucasians extreme in lack of pigment, American Indians extreme in thinness of upper incisor teeth, and Australian blacks extreme in overhanging brows, but when the biologist totals all the extremes for any one subspecies he neither proves nor implies superiority or inferiority for any subspecies. He does emphatically proclaim significant differences. To him the superiority assumed by a Nazi German Caucasian or a Shinto Japanese Oriental is only a little more unfortunate than the inferiority complex observed in occasional individuals of several other races. To him, the biologist, the prospect of a world brotherhood in which all men everywhere are subspecifically the same also is unalluring because it robs the world of variety and hence of much that is of interest. For the zoologist—and probably most men hold the same view—an improved world order should insure the opportunity to each subspecies to perpetuate itself, if it so chooses. Many think that a more progressive species, as well as a more varied and interesting one, will be the result if each subspecies preserves itself, if necessary by deportation of "invaders" which have a higher birth rate and who are of another subspecies. Obviously, therefore, in some countries or in certain selected political areas, it would be necessary to grant citizenship rights to one subspecies only. Advocates of this policy would encourage the interchange of scholars, teachers, scientists, skilled craftsmen, commercial representatives, and others to the maximum but citizenship for one of these selected areas would depend on zoological subspecies.

Is it partly on this basis and not alone on the important bases of commerce, politics, religion, and the historical record that political boundaries might well be established at coming assemblies of the United Nations Organization? Changes in the adopted constitutions of some countries would be required, it is true, but, wherever possible it would seem better to make these changes than to preserve constitutions which encourage violations when war does come. Witness the North American violations in the war just ended of the constitutional rights of

citizens who were of the subspecies *asiaticus*, race Japanese. It would seem to be far better for all of us, as with any kind of truth, to recognize the biological differences between the subspecies of man and by providing some areas in which citizenship for one subspecies alone will obtain, apply the available zoological knowledge so as to promote harmony instead of discord and so lengthen the present interval of peace.

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NOTES ON THE DALL PORPOISE OFF CALIFORNIA

By Charles F. Yocom

According to the statement of Cowan (1944, p. 295) the range of the Dall porpoise is as follows: "The Dall porpoise, *Phocoenoides dalli* (True), occupies a rather restricted range in the northern Pacific. On the American side this extends from the Aleutian Islands to Santa Barbara Channel, California, but the known occurrences south of Canadian waters are so few that they may be of extralimital or vagrant nature. Certainly the center of abundance lies in the coastal waters of northern British Columbia and southeastern Alaska."

Present literature indicates that only two specimens of *Phocoenoides* have been taken in the coastal waters of California. A paper by Benson and Groody (1942) describes a specimen that was collected on October 12, 1940, at San Quentin Point, San Francisco Bay, Marin County, California, by members of the Grinnell Naturalists Society. The other was collected by Mr. E. Z. Rett and Mr. M. E. Rodehaver on June 12, 1925, in the Santa Barbara Channel between Santa Cruz Island and Santa Barbara, California, and was reported to have been one of a group of about ten individuals (Benson and Groody, 1942).

The above authors refer to several specimens of *Phocoenoides* which were taken in Alaskan waters. Cowan (1944) reported that in the summer of 1939 the British Columbia Provincial Museum obtained five complete skeletons of the Dall porpoise, including three males and two females, from the waters adjacent to Queen Charlotte Sound, British Columbia.

Cowan states that during the summer months the Dall propoise inhabits certain channels between the many islands flanking the coast north of Vancouver Island, and the channels selected seem to be the ones having broad openings at both ends characterized by strong tidal currents. Dall porpoises were seen in Goletas Channel, Fitzhugh Sound, Queen's Sound, Millbank Sound, Laredo Channel, Otter Channel and Principe Channel but were not recorded from the Gulf of Georgia, the Strait of Juan de Fuca or the west coast of Vancouver Island. In the Queen Charlotte Sound region these porpoises were seen in groups of from two to twelve individuals.

RECENT SIGHT RECORDS

The author, while serving in the United States Navy, often had the opportunity to look for porpoises in the coastal waters of California. In all, ten trips

were made between February 22, 1945, and September 15, 1945, past the Farallon Islands in going to and from Treasure Island, San Francisco, California. Dall porpoises were seen by the writer and crew on six of the trips. Table 1 summarizes the results of the observations.

The author's ship would "lie to" on station for a period of four weeks at a time. The stations maintained while the writer was aboard were located between four and eight hundred miles off the coast of California, except for one which was located approximately 460 miles directly west of Cape Blanco, Oregon, at 43°N. 135°W. Dall porpoises were not seen at any of these stations, so it is unlikely that they get so far out from the coastal waters. The location of the stations and dates maintained while the writer was aboard are:

TABLE 1.—*Observations on Dall porpoises in the vicinity of the Farallon Islands, 1945*

DATE	NUMBER OF PORPOISES SEEN	DATE	NUMBER OF PORPOISES SEEN
February 22....	None (stormy)	July 5	10
March 19.....	15 (approximately)	August 1.....	15 or more
April 8.....	None (stormy)	August 21.....	Several unidentified
May 3.....	None (calm)	September 14....	3
May 22.....	None (stormy)	September 15....	4 or more
June 17.....	3 (others unidentified)		

Date Maintained	*Location of Stations*
February 24 to March 19	34° N. 131° 31′ W. (500 mi. from San Francisco)
April 10 to May 1 May 23 to June 15	34° 40′ N. 129° 50′ W. (400 mi. from San Francisco)
July 8 to July 19 August 23 to September 12	43° N. 135° W. (465 mi. W. Cape Blanco, Oregon)
July 22 to July 27	31° 40′ N. 136° W. (800 mi. from San Francisco)

The first Dall porpoises observed by the writer were seen about noon on the 19th of March approximately 25 miles southwest of the Farallon Islands near the edge of the continental shelf. Several were noted leaping out of the water on our starboard bow as we came in from the sea towards the channel. Five approached the ship and made continuous leaps and dives in front of our bow for nearly 15 minutes. The distance from the eyes of the ship to the water line is about 12 feet so that from the bow these porpoises could be observed very closely. As the porpoises came to the surface to breathe, and then turned and rolled on their sides as they dived under the bow, their white sides and bellies could easily be seen. There was little chance of mistaking their identity.

On the next trip, begun April 8, the weather was stormy so that few observations were made and no porpoises were seen. When the ship came in on May 3 the sea was calm, but again porpoises were not seen. Rough seas also prevailed between the Golden Gate and the Farallons on our way to sea on May 22, and no *Phocoenoides* were seen although they may have been present.

On June 17, approximately 20 miles southwest of the Farallons, three Dall

porpoises approached our ship as we came in from the sea. They leaped in front of the bow for two or three minutes and then departed. Their white sides were clearly evident. Other groups of porpoises (unidentified) were noted several hundred yards off from the ship; their actions indicated that they might have been *Phocoenoides*, but the distance was too great to allow identification.

On July 5 at 2:30 p.m. three Dall porpoises came dashing in towards our ship. They, like the others I have seen, seemed to enjoy leaping and diving just in front of the bow. Three minutes later two more porpoises were sighted 100 yards off the port bow; they, however, did not come any closer to the ship and soon were off some distance. The position of the ship at that time was approximately two and one half miles southwest of the Farallons in about 60 fathoms of water. Later two Dall porpoises were seen near the ship at 37° 42′ N. 123° 45′ W. (approximately 36 miles west of the Farallons in 1500 fathoms of water).

At 4:00 a.m., August 1, Robert Mindenhall, Signalman, noted approximately 12 porpoises leaping in front of the ship which was at that time nearly 8 miles south and 2 miles west of the Farallons in 300 fathoms of water. He stated that these porpoises had white sides and bellies and that their actions were similar to those of Dall porpoises observed previously.

On August 21, dense fog limited visibility to 500 feet or less so that observations were much restricted as the ship followed the channel between the Golden Gate and the Farallon Islands. The fog lifted, however, after the Farallons were passed. Four miles west of the Farallons a group of porpoises was sighted. Their actions resembled those of *Phocoenoides* but they were too far away to be identified with certainty. The depth at this place was approximately 60 fathoms.

Ensign W. Winstanley, USNR, during the afternoon of September 14, observed two porpoises with white sides leaping and diving in front of the ship. The ship's position was at 38° 02′ N. 125° W., 100 miles west of the Farallons in over 2200 fathoms of water. On the following morning, September 15, four Dall porpoises were seen at close range at a point 15 or 20 miles from these islands.

On several occasions the writer saw bay porpoises (*Phocoena phocoena*) in the channel between the Farallon Islands and the Golden Gate Bridge; some were seen in the Bay near Alcatraz Island. Dall porpoises were never seen, however, in this area.

The waters around the Farallons extending approximately seven miles west, many miles north and south, and east to the mainland are less than 500 fathoms in depth. In fact, in most of this area, except for some of the waters west of the Islands, the depth is less than 50 fathoms. About 15 miles west of the Farallons the depth increases to 1000 fathoms except at Pioneer Seamount (450 Fathoms) and other shallow areas. Approximately 40 miles from the Farallons the depth is more than 2000 fathoms. Most of the porpoises were seen within the area which is considered as being a portion of the continental shelf.

COLORATION

The main body color of the specimens seen by the writer appeared to be a very dark steel gray. The white area on their sides seemed to be quite uniform;

detailed observations, however, were difficult to make for the ship was underway each time that porpoises were seen. The porpoises, also, were continually surfacing and diving which further complicated detailed observations.

On July 5 three porpoises that swam in front of the ship's bow were noted by the writer with particular attention being given to the pattern of their white sides. On each individual the white area extended well up on its side and forward to the proximity of the anterior edge of the dorsal fin. From here the white area extended in a sloping line to the base of the tail. The ventral portions of their bodies were white; this was noted as the porpoises occasionally rolled over on their sides in making a dive. All of these porpoises had white dorsal fins and white fringes on the posterior portion of the flukes.

All other *Phocoenoides* seen at close range had the distinctive white sides and bellies but close attention to the distribution of the white areas was unfortunately not recorded. According to detailed observations made on captured specimens there is considerable variation in the color pattern of the white areas (Benson and Groody, 1942; Cowan, 1944).

BEHAVIOR

As previously mentioned, this species appears to enjoy a good run with a ship, and a group of these handsomely-marked porpoises make a spectacular display when surfacing and diving just ahead of the bow of a ship.

Whenever a group of Dall porpoises came close to the ship a few or all of them would give chase. Sometimes they would get directly in front of the ship and continue to surface and dive for as long as 15 minutes before swimming away. At other times they would dart in near the ship only to turn and dart away again. Often when diving in front of the bow some individuals would roll over on their sides and backs and act as though they were trying to rub their bellies on the keel of the ship. Bay porpoises observed by the writer showed no tendencies to leap in front of the ship as do *Phocoenoides*.

The writer had no way to determine accurately the maximum speed of this species; however, the porpoises that swam in front of the ship appeared to maintain their position with little effort even though the ship's speed was usually 10 or 12 knots. Porpoises that approached the ship from the side were seen to put on spurts of speed and easily overtake it.

STATUS IN CALIFORNIA WATERS

Benson and Groody (1942, p. 50) stated that the status of the Dall porpoise in California waters was uncertain; that it might be a sporadic visitor, a seasonal visitor, or perhaps a rare permanent resident. Scheffer's observations (1942) indicated that it was relatively common in May and December. Records are now available for all months except January, February, April, and December. It seems probable that additional observations would show that this porpoise is a permanent resident near the Farallons. Members of my ship's crew told me that Dall porpoises were seen many times in the vicinity of the Farallons before I reported for duty in February. Some commercial fishermen, familiar with the Dall porpoise in Alaskan waters, have also told me that the species is a

resident in the waters around the Farallons but is less numerous there than in Alaskan waters. I made no observations in the shallow waters near Noonday Rock, North Farallon and Middle Farallon islands, nor in the coastal waters along northern California and Oregon. Future observations in these areas may show that the Dall porpoise is much more common in the coastal waters of California, and possibly of Oregon and Washington, than has been supposed in the past.

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FURTHER NOTES ON THE DALL PORPOISE

By Seth B. Benson

A recent article on the Dall porpoise, *Phocoenoides dalli* (True), by Cowan (1944), based on five specimens from British Columbia, prompted me to re-examine the material which was reported on previously by Benson and Groody (1942). The chief basis of this 1942 report was an adult male collected in San Francisco Bay, California. Although most of the details described by Cowan agree with the previous accounts of this species, and with the specimens available to me, some do not. As a result, some of his conclusions and interpretations are not applicable to all known specimens. It seems apparent that these are still too few to permit a fully satisfactory characterization of the species, as the range of individual variation is great and its limits not yet known.

Cowan states that the form of the caudal peduncle in his largest specimen of *dalli* closely approximates that figured by Andrews (1911) in his original description of *Phocoenoides truei*. This is in agreement with the conclusions of Benson and Groody. He indicates that the height of the caudal peduncle is even greater in his largest specimen, giving the height as 285 mm as compared with 204 for *truei*. The latter figure is an error, for Andrews' measurement is 304. This approximates the measurement calculated for the California specimen. His further suggestion that the caudal peduncle extends farther caudad in *truei* than in *dalli* is not borne out by the specimen from San Francisco Bay when comparison is made with the photographs of the type of *truei*. The suggestion that the peduncular hump becomes more pronounced with age is probably correct, for it is most pronounced in the California specimen, which is older and larger than any of the specimens of the genus so far reported.

The suggestion that there may be secondary sexual differences in the shape of

the head is not supported by the evidence. Cowan mentioned that the photograph of the California specimen did not appear to support his view, but indicated that the details of structure could not be well distinguished in the illustration. The original photographs show detail clearly and there is no difference in shape of the head between this adult male and the young female shown in his photograph. Both are similar to the type of *truei*, also a male, which was excellently figured by Andrews. Unfortunately, the males examined by Cowan are not figured in his paper, and it is not clear if the comparisons were made between the specimens themselves or photographs.

There is also a suggestion that the direction of the mouth line may be different in the two sexes. Quoting from Cowan (1944, pp. 298–299): "Both the males, furthermore, have the mouth line directed in the same plane as the horizontal axis of the body. Indeed, projected, it would cut the body to the flukes, whereas in the females the projected mouth line would pass out of the body in the vicinity of the dorsal fin. This possible sexual dimorphism does not appear in the photographs of the San Francisco Bay male, but is apparently the case in the Santa Barbara specimen figured by Benson and Groody. It is difficult to ascertain just how much of this difference is attributable to position of the head. Possibly the more elevated position exhibited by the two males reflects sexual disparity in the levator and depressor muscles of the head manifest in the head position assumed during rigor mortis". In this regard, if there were a real difference in the direction of the mouth line, it would show itself in relation to the position of the eye and the structure of the jaw. No significant difference is visible in the photographs of the type of *truei* (male), the San Francisco Bay specimen (male), and the young female figured by Cowan. The photographs available to me clearly show that the central position of the head is merely a positional effect resulting from gravity. Thus the male from San Francisco Bay is "male" when suspended by the flukes and "female" when supported on the ventral surface. The male type of *truei* is also "female" in the photographs (Andrews, fig. 3 and plate 2). The Santa Barbara specimen cannot be used as evidence in this regard for the sex is not known and even in the original photograph the direction of the mouth line cannot be seen. The head position is central because the specimen is suspended. It seems unlikely that sexual differences in rigor mortis should occur. My impression after collecting and handling several porpoises is that rigor mortis is a transitory phenomenon and that the degree of stiffness attained is insufficient to resist the effects of gravity on the heavy body in different positions.

The statement that there is no indication that variations in color pattern or intensity can be associated with either age or sex is probably true as regards pattern. While Cowan does not give a detailed description of the color of each specimen, it does appear from such description as he does give that the younger specimens were less intensely pigmented than the older ones. The San Francisco Bay specimen, apparently the oldest yet known, was intensely pigmented and the light and dark areas sharply contrasted. The type of *truei*, also fully adult, was intensely pigmented. More specimens are needed to determine this point

with certainty. However, in view of the large amount of variation in color and pattern it is possible that Cowan's view is the correct one.

Cowan reports that the "gum teeth" in his fresh specimens were even greater in size than in the preserved material reported upon by Miller (1929), and that the true teeth were practically functionless. This is not in entire agreement with the specimen reported on by Benson and Groody. In this specimen, the "gum teeth", while clearly serving as grasping structures, were not higher than the true teeth. The fact that the true teeth were missing from the areas of greatest use, and that some of those remaining were much worn, indicates that they were not entirely buried in the gums and protected by them. It was suggested by Benson and Groody that the differences between the specimens described by Miller and the San Francisco Bay specimen may have been the result of differences in the method of preservation. Since Cowan's material was observed when fresh this suggestion was in error. It now seems most likely that these differences in palatal rugosities and height of "gum teeth" are associated with age. Probably the "gum teeth" and rugosities wear down with use so that in old individuals the true teeth become exposed to wear. The condition of the gums and teeth in *truei* as described by Andrews is in agreement with this view. It is obvious from other details that Cowan's specimens were younger than the type of *truei* and the San Francisco Bay specimen.

The asymmetry in the skull of Cowan's specimens is present in the two specimens in the Museum of Vertebrate Zoology. In contrast, in ten specimens of *Phocoena* from California the asymmetry is less pronounced and in the opposite direction. This character, therefore, may be of generic value.

Cowan stresses as particularly significant the observation that the dental alveoli in *Phocoenoides* are incomplete, whereas in *Phocoena* and *Lagenorhynchus* some in the central region of the tooth row are always complete. This was not checked on the San Francisco Bay specimen as the gums have been left on the skull to hold the teeth in place. It was not necessary to remove the gums to check this, for in another specimen (MVZ no. 4755) of *dalli*, some complete septa are present. Examination of the *Phocoena* skulls in the collection revealed that the interalveolar septa are of delicate construction and easily destroyed in preparation, especially in young individuals. In some specimens, cleaned too completely by dermestid beetles, the septa had been entirely removed. Also, in very young specimens of *Phocoena* the septa are not ossified. Since the caption for the lower figure of plate 1 of Cowan's article states that the gum tissue was removed by dermestid beetles, it is quite possible that they may have removed the soft bone of the septa as well. In any event, the character is not of generic significance since the septa are present in a specimen of *Phocoenoides*. But it is true that they are much less developed in this genus than in *Phocoena*.

In the two specimens available here the mandible is longer and relatively more slender than in *Phocoena*, as Cowan states, but the position of the coronoid in relation to the articular facet varies so widely, in both genera, that a generic distinction in this character does not exist. On the basis of our specimens, *Phocoena*, not *Phocoenoides*, most nearly resembles *Lagenorhynchus*.

The scapula of *Phocoenoides*, as compared with that of *Phocoena*, is not strikingly long in comparison with its greatest breadth, as was stated by Andrews and reaffirmed by Cowan, at least as far as ratios of measurements are concerned. Andrews' statement (1911, p. 4) concerning *truei* is: "The most striking feature of the scapula is its extreme height in proportion to its width, the vertical height being but little more than the greatest breadth." The statement contains an error, for, as the measurements and photograph show, the breadth is greater than the length. The statement would be correct were "vertical height" and "greatest breadth" transposed, or "less" substituted for "more." Aside from this, while the scapula of the type specimen of *truei* is long in relation to its width, other specimens of the genus show so much variation in this character that the statement that the genus is "unique" in these proportions is not true. In support of his statement Andrews gave measurements of the type of *truei* in comparison with measurements of a single specimen each of *Phocoena phocoena* and *Lagenorhynchus obliquidens*. The ratios of greatest breadth to greatest length were 110, 148 and 156, respectively. In the San Francisco Bay specimen, figured and commented upon by Benson and Groody (1942, plate 1 and p. 49), the greatest breadth is 183 mm and the greatest length is 140, giving the ratio 131. The ratio in the specimens from British Columbia is 120, as based on the averages given by Cowan, and 126, with a range of 116 to 135, when based on measurements of the outline drawings, which are about one third of natural size. The difference in the averages may be the result of differences in selecting points for measurement, but more probably is the result of magnification of errors made in measuring the drawings. On the other hand, the corresponding ratio obtained from measurements of four specimens of *Phocoena* from San Francisco Bay is 126, ranging from 116 to 130. It is obvious from this overlap that *Phocoenoides* is not "unique" or "striking" in this character when compared with *Phocoena* as a genus, whatever the condition may be in specimens of *Phocoena* from other localities.

The photographs and drawings now available show that there is much variation in details of structure, as well as in the general shape, of the scapula. Although some of this is individual variation, a part is attributable to age. Ossification, especially on the vertebral border of the scapula, apparently continues throughout life. Cowan mentions individual variation in his specimens in details of structure, but his mention of a metacromion is probably a lapse for coracoid process, because the latter, which he does not mention, is strongly developed, while the former is apparently absent.

The scapula of *Phocoenoides* is more angular than that of *Phocoena*. The vertebral border is more nearly straight and more nearly parallel with the acromion, coracoid process, and plane of the glenoid fossa. The axillary border is relatively longer and forms a smaller angle with the scapular spine. But the scapula is not relatively narrower.

Differences between *Phocoenoides* and *Phocoena*, not mentioned by Andrews or Cowan, are the relatively greater breadth and thinness of the manus, and greater curvature and spreading of the digits in *Phocoenoides*. The much greater

width of the ulna distally and proximally was remarked upon by Andrews and illustrated in an excellent photograph. Other points of difference are that the fifth metacarpal lies parallel and almost in contact with the distal part of the ulna, and that the fifth digit is perpendicular to the main axis of the manus.

The minor modifications Cowan suggested for Andrews' characterization of the genus *Phocoenoides* are improvements with the exception that Andrews' statement "teeth very small, the crowns compressed and separated from the root by a slight constriction", should be reinserted in place of "teeth vestigial", and the statement "interalveolar septa nowhere complete" should be omitted.

The degree of systematic relationship between *dalli* and *truei* is left an open question by Cowan in the absence of sufficient evidence to indicate definitely if the two "types" are distinct species, subspecies, or mere variants. He points out that the greater extent anteriorly of the white lateral patches and the shape of the black circumanal area are the only characters remaining of those listed by Andrews as distinguishing *truei* from *dalli*, and that how much these differences warrant recognition of two species or subspecies is a matter of personal opinion. Since the range of variation in pattern in American specimens is not yet known to include the condition present in the yet unique specimen of *truei*, he suggests that *truei* may be a local variant, perhaps with a definite geographic range in certain Asiatic waters He concludes (1944: p. 306) "further observations on the intermingling and possible interbreeding of the two types are needed to provide a basis for the drawing of more precise conclusions."

Such care in coming to decisions on systematic matters is ideal, but, unfortunately, has not always been exercised by systematists, in part because such detailed information is not always available to them. The systematics of cetaceans particularly is overloaded with description of "species" based on incomplete evidence, and if it is necessary to recognize each of these as valid until absolutely convincing evidence to the contrary concerning each one is available our understanding of cetaceans will remain distorted and confused for some time to come. The description of *truei* is superlatively complete in comparison with most original descriptions of cetaceans, but, as is obvious from the description, the degree of relationship to *dalli* could not be ascertained at that time. At present, however, the best procedure is to consider *truei* as a synonym of *dalli* since the newer evidence points in that direction. As Cowan points out, the significance of the differences in color pattern is a matter of opinion. It is obvious that the few specimens for which accurate data on color and pattern are available show much individual variation. In view of the close correspondence in other characters, including color and pattern, the value of the differences in minor details of pattern as a basis for distinguishing two kinds when the specimens are so few is certainly open to question, particularly in view of other factors having a bearing on the situation.

Cowan inclines to the opinion that the range of *dalli* is of a rather restricted nature, that the center of abundance is in the coastal waters of southeastern Alaska and British Columbia, and that the recorded occurrences south of Canadian waters may be of extralimital or vagrant nature. This may be true as

regards southern distribution although the observations of Scheffer (1942) indicate that the species may occur along the Pacific coast of the United States more commonly than was formerly believed. Certainly it is indicated that if not resident there the species ranges widely. Also, the apparent center of abundance in the coastal waters of southeastern Alaska and British Columbia may merely reflect a greater amount of observation there than in other waters of the North Pacific. The Aleutians, for instance, where *dalli* is known to occur, have been less visited by naturalists, and little is known of the Asiatic coast. It is also pertinent to remark that the type locality of *dalli*, the strait west of Adak Island, lies far out in the Aleutians in a longitude which is about 275 miles west of the longitude passing through the most eastern part of Siberia. The type locality of *dalli* is 2100 miles directly west of the coast of British Columbia, and the type locality of *truei* is an equal distance southwest of Adak Island. Since *dalli* ranges about 1000 miles south from British Columbia, and has been observed a considerable distance offshore, it seems it would not be difficult for this porpoise to follow the islands west and southwest from the type locality and range to the shores of Japan. This distance is much less than that from Adak Island to the Channel Islands of southern California. It is obvious that the range of *dalli* is not "restricted" except in comparison with the more pelagic cetaceans.

The type locality of *dalli* is approximately central in the known range of the genus, and since there are no obvious barriers to distribution to the east or west, it seems better to think of this porpoise as a North Pacific species rather than that there are distinct American and Asiatic populations, especially since Ogawa (1938) has already reported both types in Japanese waters and considered them the same species. On an ecological basis it would not be expected that forms as similar as *dalli* and *truei* should exist as distinct species in the same area. However, I agree with Cowan that the matter cannot be definitely settled until more evidence is available. Perhaps some of the mammalogists now in the armed services will have opportunity to make the necessary observations in Aleutian and Asiatic waters.

[The preceding account was written more than a year ago but was withheld in the hope of obtaining additional data. Several mammalogists in the armed services who visited the Museum of Vertebrate Zoology were asked to make observations on the range and external characters of the Dall porpoise. Most were unable to do so; but Mr. C. F. Yocom, then an Ensign in the United States Naval Reserve, made observations off the coast of California and Oregon in the period February to September 1945. These observations he records in an accompanying article. They indicate that *Phocoenoides dalli* is of common occurrence in the latitude of San Francisco and probably is a permanent resident there. Trustworthy sight records are now available for all months except January, February, April, and November. Reports of fishermen, familiar with the Dall porpoise in Alaskan waters, indicate also that the Dall porpose is regularly present in the vacinity of the Farallons although less numerous than in Alaskan waters.

Yocom recorded detailed observations on color pattern at close range on only three individuals. These were all of the "*dalli*" type as regards the anterior extent of the lateral white patch but had the white markings on the dorsal fin and flukes formerly regarded as characteristic of *truei*.]

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RECORDS OF THE BLACKFISH OR PILOT WHALE FROM THE TEXAS COAST

BY GORDON GUNTER

The first exact knowledge the writer had of the blackfish, *Globicephala*, on the Texas Coast was given to me by Mr. Curtis J. Hesse, as related in the paragraph below. Later Dr. Asa C. Chandler of The Rice Institute, Houston, Texas, informed me by letter that two specimens had previously been brought to the attention of the Department of Biology of that institution. One was washed up on the beach near Velasco, Texas, in the summer of 1936 or 1937. It was identified by Dr. Chandler. Arrangements were made to have the carcass watched and the skull saved, but the man who was to do the job failed to carry out instructions properly and no skeletal remains were saved. A headless specimen washed up on the beach near Aransas Pass, and on March 28, 1938, a group of people from The Rice Institute examined the carcass. Some vertebrae were saved and are now at the Institute. It was tentatively concluded that the animal was *Globicephala*.

The late Curtis J. Hesse, although primarily a paleontologist, was interested in a wide variety of subjects. In the summer of 1942 he called me into his office in the Texas A. and M. College Museum, at College Station, and showed me a *Globicephala* skull with a bullet in it. He said it had recently come to him from Freeport, Brazoria County, and was dug up from a depth of about 10 feet in the ground during the construction of a defense plant. Freeport is on the Brazos River delta where deposition is very rapid and, in spite of the depth from which it came, the skull was indubitably Recent. Hesse and I discussed the matter and agreed to collect more records on Texas marine mammals. Neither of us got around to working on the matter and most unfortunately Mr. Hesse passed away suddenly in May 1945, while in his very prime. The writer had no data on the *Globicephala* skull other than that verbally given. On

November 8, 1945, Dr. Wm. B. Davis and I made a search for the skull in the A. and M. Museum but it was not found. Mr. Hal W. Parks, present curator of the museum, located some correspondence on the specimen and a small photograph, which was forwarded to me by Dr. Davis. On the back of the photograph the following information was typed:

> "Skull, Freeport, Texas
> June 26, 1942, dredged up from wall
> of canal 8 ft. beneath surface had 45. cal.
> copper jacket bullet in mud between nasals.
> Texas A. and M. Museum, College Station,
> Texas."

No measurements were given, but a watch and set of keys were included in the picture to show the scale. From this it appears that the skull was around 2 feet

TABLE 1.—*Measurements of two Globicephala from St. Joseph Island, Aransas County, Texas*
(Skull measurements were made with a meter stick and are only approximate.)

	MAY, 1940	SEPTEMBER, 1945
Total length of animal	17 feet (approximate)	12 ft., 10 inches
Teeth	6 above	6 above, 5 below
Length of left pectoral fin	—	2 ft., 1 inch
Width of flukes	—	3 ft., 2 inches
Length of skull	695 mm.	600 mm.
Zygomatic width	508 "	450 "
Interorbital width	465 "	390 "
Width at notch	285 "	235 "
Width at mid-rostrum	250 "	203 "
Nasals to maxillary	458 "	405 "
Mandibular length	—	493 "

(610 mm.) long. The right maxillary bone was broken off at about the midpoint between the maxillary tip and nasal orifices and was missing.

In May 1940, a *Globicephala* washed ashore on the Gulf beach of St. Joseph Island, Aransas County, which lies between Aransas Bay and the Gulf of Mexico. Mr. Clyde Townsend, foreman of the ranch on the island, who was my informant concerning this porpoise, said it measured 17 feet in length. When the animal rotted he saved the skull and gave it to Mr. W. C. McGuire, of Houston, Texas. Through the kindness of Mr. J. L. Baughman, also of Houston, Mr. McGuire was traced and persuaded to donate the specimen to the U. S. National Museum, after letting the writer examine it. It is now in that museum as number 279366. The skull measurements are given in the table. The mandibles were not present.

On September 5, 1945, a small pilot whale was seen by cowboys from the island ranch, stranded in shallow water on the Gulf beach of St. Joseph Island. It was alive but, according to Mr. Clyde Townsend, still shallower water lay between it and open water and it never would have been able to get back to water of swim-

ming depth, so he dragged it ashore with a truck. He said it made a low bellowing sound somewhat like an angry bull and threshed the ground with its tail. The sounds were repeated about 6 times over a period of about 15 minutes. The noise must have come from the expulsion of air through the various air passages, since whales possess no vocal organs. Kellogg (1940, p. 70) says this species when stranded "is said to make a bellowing noise and this seems to be the basis for the name 'Caa'ing', or Calling Whale." Fraser (1938, p. 304)on the other hand states, "It may be stated that the Scottish name Caa'ing Whale is connected with the practice of driving or herding the animals, and has nothing to do with calling or vocal expression of any sort." The fact remains that pilot whales are notorious for their predilection for becoming stranded and there is evidence that they bellow or call at such times. I questioned Mr. Townsend carefully about this matter and he was firm in saying that the noise made was a distinct bellowing sound and that it came from the mouth. He said he was not more than 5 feet from the animal's mouth when some of the sounds were made.

On September 13, 1945, the writer first saw the specimen. The globular head and coal black skin served to identify it immediately as the blackfish or pilot whale. It was already decaying and the skin was sloughing off in spots. The total length, measured with a steel tape, was 12 feet and 10 inches from the snout to midpoint of the flukes. Measurements of the left pectoral fin and flukes are given in the table. Teeth were seen, but were not counted. Photographs of the specimen were taken. Due to its putrid condition no other measurements and no dissection was made.

The carcass was left and the bones were gathered on October 24, 1945, after the process of putrefaction was practically complete. In the meantime it had been moved higher on the beach by the tide. According to Mr. Townsend, carcasses are always moved higher on the beach by the tides, but are never washed out to sea.[1] Dr. Remington Kellogg wrote me that when schools of blackfish become stranded on the East Coast the carcasses remain until, in the populated districts, the residents prevail upon the U. S. Coast Guard to tow the putrid remains out to sea.

All bones of the St. Joseph Island specimen were not recovered. Those that were are deposited in the Texas Cooperative Wildlife Collection at the A. and M. College of Texas. The catalogue number is 3668. It was noted that several of the bones had small spinous processes on the surface, not detectable at first glance, but which were long and sharp enough to cut the hands. Possibly, since the animal was evidently young, these spines were where new bone was

[1] The rising tide is a stronger force than the falling tide because the force of the rollers or breakers work with it. To the contrary, the breakers work against the falling tide and tend to keep floating objects shoved towards the beach. In short the rising tide shoves floating objects landward with considerable force, while by comparison on a falling tide the water gently recedes. For this reason it appears that all floating objects along the shores of the sea tend to become stranded on the beach at the highest point where they ground. This conclusion is confirmed by the collections of logs, trees and other objects far up on the beach near river mouths. Such driftwood on the Texas Coast may be observed lying in the dry sand far beyond the reach of ordinary high tide.

being formed under cartilage. I am indebted to Dr. Wm. B. Davis for assistance in measuring the skull. All teeth were absent and I was told that they had been removed by the cowboys for souvenirs. Both of the skulls examined by the writer were slightly asymmetrical, being twisted somewhat to the left. The skull formerly in the Texas A. and M. Museum had the same characteristic.

Lowery (1943), gave an account of forty-nine blackfish, *Globicephala ventricosa* (Lacépède), which went ashore near the mouth of Bayou Lafourche, Louisiana, at the time of a hurricane on August 5, 1940. He took photographs of the carcasses on August 19 and collected one skull, which was deposited in the Museum of Zoology, Louisiana State University. Twelve of the animals he measured ranged from 5.3 to 18.5 feet long, with an average length of 10.0 feet Some must have been newly born.

Cope (1876) described *Globicephala brachyptera* from Delaware Bay. True (1889) considered that this was the South Atlantic and Gulf of Mexico species and that *G. melas* (Traill), later called *G. ventricosa* (Lacépède) by most American mammalogists, was the North Atlantic species, with the coast of New Jersey being about the dividing line. However, some authorities today feel that the short fin, upon which Cope largely based his species, is not definitive, and others doubt that there are two Atlantic species with a fairly sharp range limit. Therefore, it seems best to hold to the old name *Globicephala ventricosa* (Lacépède) until there are enough skulls deposited in the museums to settle the matter properly. However, it should be pointed out that the left pectoral fin of the specimen I measured was slightly less than one-sixth of the total length of the animal, as Cope (*op. cit.*) said it was for *G. brachyptera*.

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A STUDY OF THE BACULUM IN SOME NORTH AMERICAN MICROTINAE

By W. J. Hamilton, Jr.

As a systematic tool, the os penis or baculum has received considerable study in recent years. Descriptive studies have been summarized by Gilbert (1892), while Burt (1936) has listed the important papers dealing with the use of this structure in taxonomy. Burt (*ibid.*) suggested that the internal situation of this structure does not expose it to the stresses and strains as are the bones of the limbs and skulls, and points out that its true character is less likely to be disguised by extraneous factors. He concludes that the characters of the baculum should indicate to a greater extent the real affinities of the animal.

Few reports are available on the structure of the os penis in the voles and lemmings. The baculum of *Arvicola arvalis* has been figured by Gilbert (*ibid.*) but since this was illustrated at natural size, none of the trenchant characters can be observed. Tullberg (1899) has illustrated the baculum of *Arvicola amphibius* but the figure is so small that it is impossible to observe the precise characters. Didier (1943) has used the character of the baculum to ascertain the relationship of *Arvicola t. terrestris*, *A. t. amphibius* and *A. t. monticola*.

Considerable variation exists within a species and variation with age is apparent (Plate 1). Nevertheless, specific characters are for the most part fairly well marked and enable the investigator to draw conclusions regarding the relationships existing between genera, and, to a lesser degree, species may be separated from one another on the structural character of the baculum.

MATERIALS AND METHODS

I have been able to amass considerable fresh bacula of *Microtus p. pennsylvanicus*, *Ondatra z. zibethica* and *Clethrionomys g. gapperi*. I am indebted to Dr. G. Clifford Carl, Provincial Museum of Vancouver, B. C. for an alcoholic *Lemmus helvolus*, to Mr. T. Donald Carter of the American Museum of Natural History for three specimens of *Dicrostonyx rubricatus*, Mr. George B. Lay of the U. S. Fish and Wildlife Service for specimens of *Neofiber* from southern Florida, Mr. Gerrit S. Miller, Jr. for a specimen of *Phenacomys longicauda* and Mr. E. W. Jameson, Jr. for several fresh *Microtus ochrogaster*.

The bacula of small rodents are delicate structures. This is notably so with the microtines, as the small digitate processes, particularly the lateral ones, may easily be lost if the specimen has been dried in the field. Accordingly, it has been my practice to first clear fresh or alcoholic specimens in a 3–5 per cent solution of KOH, until the glans penis is transparent and has jellied or become sufficiently soft so that it may be teased away without damage to the embedded bone. Considerable care must be exercised during the period that the penis is in the solution of KOH. If the specimen remains in the solution too long, the cartilage and connective tissue which connects the distal digitate processes to the shaft of the baculum are destroyed and the identity of the various elements to each other are lost. The cleared bone is then stained in alizarin, as described by Hollister

(1934). Specimens were then photographed by Professor E. S. Phillips and drawings made from these prints.

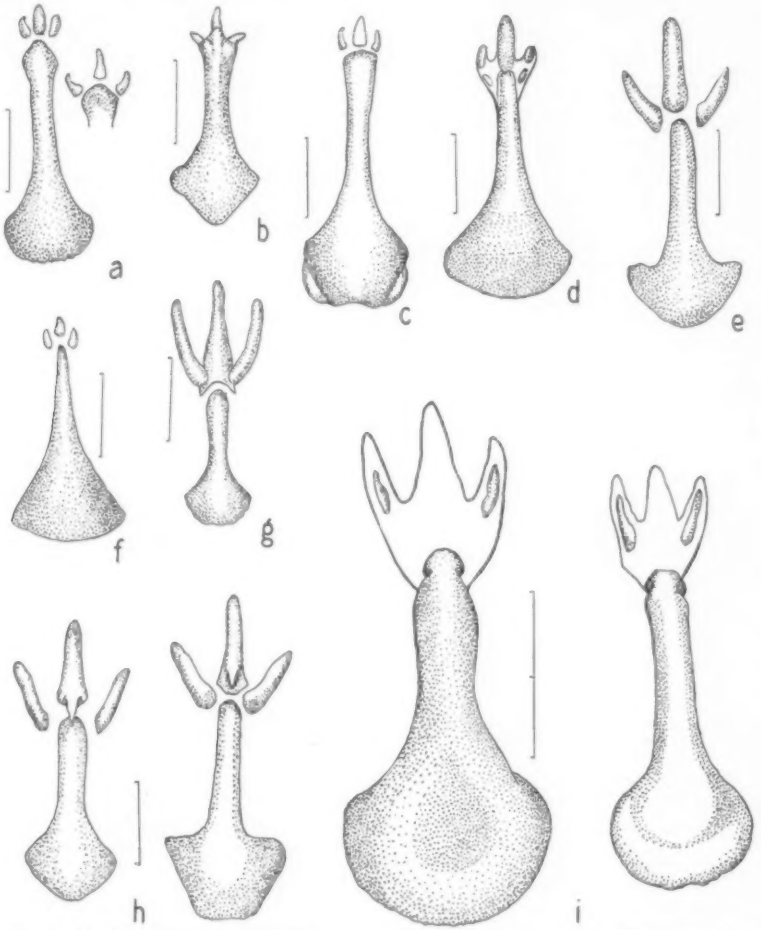

FIG. 1. The baculum of some Microtinae. a, *Synaptomys c. cooperi*; b, *Phenacomys longicauda*; c, *Dicrostonyx rubricatus richardsoni*; d, *Microtus o. ochrogaster*; e, *Microtus c. chrotorrhinus*; f, *Pitymys pinetorum scalopsoides*; g, *Lemmus helvolus*; h, *Clethrionomys g. gapperi*; i, *Neofiber alleni nigrescens*. The scale is divided in millimeters.

The genera and species are described below in the order generally accorded them in systematic works, following the implied relationships (Miller, 1896).

SUBFAMILY MICROTINAE (VOLES AND LEMMINGS)

The members of the Microtinae are a group of murine rodents closely related to the Neotominae, Cricetinae and the Myotalpinae. The Microtinae, princi-

pally upon the basis of tooth, skull, and external characters, fall naturally into two supergeneric groups, the *Lemmi* and *Microti*, or lemmings and voles. In the *Lemmi*, the skull is generally broad and massive, the lower incisors short, with the roots ending on the inner side of the molars, the crowns of the maxillary teeth scarcely, if at all, narrower posteriorly than anteriorly. The tail is usually

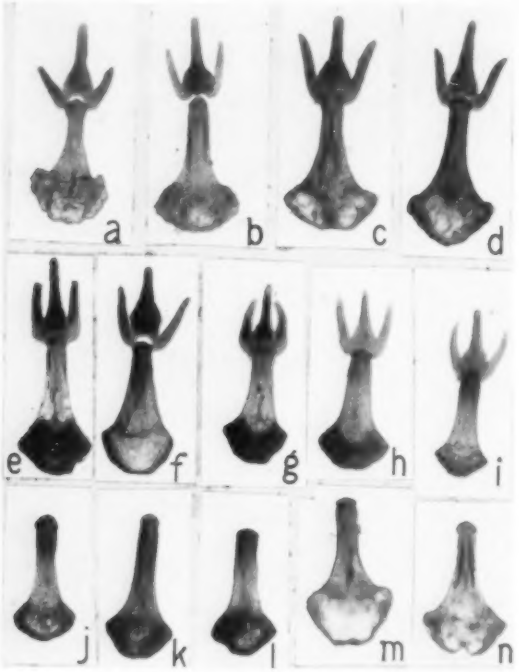

PLATE 1

Variation in the baculum of *Microtus* p. *pennsylvanicus*. Mature voles, weighing over 45 grams, are shown in a–d. Subadults are indicated in e and f. Immature males from 20–26 grams are shown in g–i. The digitate processes have 'ossified but do not show the staining well. The bacular shaft of immature voles are shown in j–i, and mature animals are illustrated in m and n. Note the prominent difference in the base of the latter two. × 3.5.

shorter than the hind foot, while the palms and soles are usually without distinct tubercles. The *Microti* have comparatively slender and lightly built skulls; the lower incisors are long, with the roots extending on the outer sides of the molars; crowns of the maxillary teeth are distinctly narrower posteriorly than anteriorly. The tail is usually much longer than the hind foot, while the palms and soles always possess distinct tubercles.

In the drawings, the unstippled areas adjoining the digitate processes to the shaft represent cartilage. As may be seen in the illustration of *Neofiber* (fig. 1-i),

the digitate processes are almost wholly cartilaginous, the bones being small and embedded in this non-osseus tissue.

Synaptomys cooperi cooperi.—The baculum of *Synaptomys* is somewhat similar to *Dicrostonyx*. The stalk has a broad, somewhat rounded base, a long narrow shaft, and an expanded, knob-like distal portion. The base is as variable as in *Microtus pennsylvanicus;* it may be rounded as indicated in Fig. 1a or may take the shape as shown in Plate 1-m. The digital processes are all small and may be closely appressed or widely separated, as shown in the illustrations. Four specimens average: overall length, 3 mm; stalk, 2.7 mm; basal width of stalk, 1.45 mm. The specimens I have studied are quite unlike *Synaptomys cooperi paludis*, figured by Hibbard and Rinker (1942). Since the figures of *paludis* represent a single specimen freed from a dried penis, it is possible that the lateral digital processes were lost during preparation.

Lemmus helvolus.—The long prominent digitate processes of *Lemmus helvolus* (fig. 1-g) and possibly other members of the genus set it off from all other genera of the *Lemmi* group and suggests affinities with the *Microti*. The stalk is comparable in appearance to immature specimens of *Microtus pennsylvanicus* (Plate 1-k) and *Clethrionomys gapperi*, although more delicate in structure. The entire dorsal surface of the base has a slight convexity, while the ventral area is slightly concave medially, possessing two ill-defined condyles. The digital processes are unique in their large size, the median process approximating four-fifths the length of the stalk. It broadens perceptibly at its base, each lateral margin carrying a spur that partially encloses the distal portion of the stalk. Just above these spurs arise the lateral processes, somewhat shorter and less robust than the median element. Measurements of the single specimen available: overall length, 3.9 mm; stalk, 2.1 mm; width of base, 1.1 mm; length of median process, 1.8 mm; lateral process, 1.3 mm.

Dicrostonyx rubricatus richardsoni.—Three specimens of *Dicrostonyx* exhibit considerable variation in the stalk. In one, the base is rounded, with a dorsal convexity, while in the specimen figured the dorsal base has condylar knobs on either margin (fig. 1-c). Ventrally, the basal condyles are separated by a deep concavity. The shaft is constricted medially, distally or of the same width throughout. Two of the shafts possess a ventral keel somewhat similar but less marked than that which obtains with *Sigmodon* (fig. 3-b). In a single specimen the lateral digital processes are partially ossified; the median process in all three are cartilaginous. Since in other microtines it is this latter process which is the first to ossify, it is possible that the median process in *Dicrostonyx* never becomes bony. Average measurements of three specimens are: overall length, 4.1 mm; stalk, 3.1 mm; basal width, 1.6 mm.

Phenacomys longicauda.—The baculum of the tree mouse, the only species of the genus which I have examined, is distinctive, and set apart from all other genera of Microtinae by its shape (fig. 1-b). The base of the shaft is roughly triangular and slightly convex, merging into a narrow central portion. The distal portion of the shaft flares slightly, forming an ill-defined tri-lobed extremity, the lateral knobs being the best marked. Ventrally, there is little differentiation, a very slight concavity noticed along the mid-dorsal line. Laterally, the shaft

shows a faint convexity. The digital processes are notable for their small size, the median process being the longest. All are firmly ankylosed to the distal end of the shaft. Measurements of the single specimen available are: overall length, 3.1 mm; length of shaft, 2.75 mm; length of median process, .35 mm.

Clethrionomys gapperi gapperi.—As with *Microtus p. pennsylvanicus*, one finds considerable variation (Fig. 1-h), and differences among individuals of comparable age is evident. *Clethrionomys*, in general appearance, most nearly approaches *Microtus pennsylvanicus*. The stalk is usually long and slender, although variation is again evident here. The ratio of the width of the distal end to that of the base varies among six individuals from 1:8 to 1:3.5. The digitate processes are similar to those of *Microtus pennsylvanicus*. A constant character is found in the median digitate process, which always supports a spur. This arises on the dorsal surface, somewhere in the proximal third of the process, and is directed caudally, ending in a sharp spine. It may terminate on the bone or project beyond the base and overlap the distal tip of the shaft. Occasionally a poorly defined spur of this nature is found in *Microtus pennsylvanicus*. Average measurements of six specimens are: overall length, 3.8 mm; stalk, 2.9 mm; basal width of stalk, 1.55 mm.

Microtus p. pennsylvanicus.—A series of 30 bacula, taken from subadults to old males (20–60 grams) illustrates well the variation with age. In young specimens (Plate 1, h–j), the base of the stalk is rounded and thin. Old individuals show considerable variation; some possess a proximal notch on the border of the stalk base (Plate 1, n), while others are similar to some specimens of *Ondatra;* still others have a base shaped like individuals of *Clethrionomys* (Plate 1,d and m). The shaft of the stalk is quite variable (Plate 1, a–c) The median digitate process is swollen at its base and frequently this process assumes a flask-shaped appearance. Occasionally a minute spur arises on the basal third of the median process and is directed proximally, as in *Clethrionomys*. In fully adult specimens, the lateral processes are compressed, blade-like structures. They arise just below the distal end of the stalk, and are directed slightly ventrad, whereas the median process is upward.

The considerable variation in a single series taken from the same locality demonstrates the desirability of examining at least several specimens of each species before making too specific descriptions. Measurements of 20 adult specimens average: overall length, 4.5 mm; stalk, 3.1 mm; width of base, 1.9 mm.

Microtus chrotorrhinus chrotorrhinus.—The baculum of this species is quite similar to several individuals of *M. pennsylvanicus* that I have examined. Essential differences are to be found in the more delicate structure, the slenderer shaft and the prominent seperation of the digital process from the shaft (fig. 1-c). The base of the shaft is roughly semi-circular with a slight depression in the middle of the dorsal surface. The ventral aspect of the base is prominently concave, without the condyles usually characteristic of *M. pennsylvanicus*. The median digitate process is somewhat flattened dorsoventrally, with a mere hint of the spur figured and discussed under *Clethrionomys*. Additional specimens may prove it to be indistinguishable from *M. pennsylvanicus*. Measurements of

a single adult are: overall length, 4.1 mm; length of shaft, 2.6 mm; basal width of shaft, 1.6 mm; length of median process, 1.2 mm.

Microtus o. ochrogaster.—The baculum of *M. ochrogaster* differs markedly from other species of the genus *Microtus* and is properly allocated subgeneric rank. The stalk is heavy and broad, with a wide thick base (fig. 1-d). Dorsally, the center of the base is slightly depressed; this condition likewise obtains on the ventral portion, with two roughened condyles bordering the edge. The stalk is straight. In 7 adults that I have examined, a single individual only illustrates the lateral digitate processes, and these are not fully ossified. Those that I have studied differ markedly from the baculum of *Microtus ochrogaster taylori* figured by Hibbard and Rinker (1942a), particularly in the shape of the base. The proximal end of the median digitate process usually overlaps the terminal portion of the stalk, but in a single specimen the process is separated by cartilage. Measurements of 7 specimens average: overall length, 4 mm; stalk, 3.4 mm; basal width of stalk, 2.3 mm.

Pitymys pinetorum scalopsoides.—A long stalk and relatively small digitate processes characterize *Pitymys* (fig. 1-f). The stalk is broad at its base, narrowing abruptly to the distal end. Dorsally, the base of the stalk is slightly concave in its center and somewhat elevated laterally. The distal portion of the stalk is rounded, slightly more flattened laterally. The median digital process is rather arrow-shaped, and somewhat larger and stouter than the lateral processes. These latter small bones are very slightly compressed. Average measurements of 2 specimens are: overall length, 2.9 mm; length of stalk, 2.5 mm; width of base 1.5 mm; length of median digital process, .27 mm.

Neofiber alleni nigrescens.—The two specimens available, from adults of comparable size, exhibit considerable differences in the character of the shaft, but in general follow similar patterns, and may at once be distinguished from any other microtine genus (fig. 1-i). Both show a narrow rounded distal shaft, swelling abruptly and then narrowing caudally to the central part of the shaft where the narrowest portion obtains. Here, in the larger of the two specimens, the shaft flares rather abruptly and merges into the proximal end, which forms a broadened, semi-circular base. The center of the proximal portion of the shaft and the enlarged base are moderately concave. In the smaller of the two figured, the shaft flares little toward the base, which is less acute and more regular in outline, the proximal margin lending the appearance of an epiphysis. There is no apparent ossification in the median digitate process, although the small bones of the lateral processes stain readily. The lateral processes of the smaller of the two specimens are considerably the largest, suggesting that in some individuals actual ossification may occur in the median process. Average measurements of the two specimens are: overall length, 5.1 mm; length of shaft, 4.3 mm; width of base, 2.3 mm; length of lateral process, .65 mm.

Ondatra zibethica zibethica.—The baculum of the muskrat, as might be assumed from the size of the animal, is the largest of the group (fig. 2). Dorsally, the proximal end of the stalk is broad and flaring, roughly rectangular in shape. The dorsal crest of the upper part of the base is scalloped and roughened. This

broad base slopes dorsoventrally at a 30° angle. Ventrally the base of the shaft is slightly concave, with two prominent lateral condyles. These are often rough-

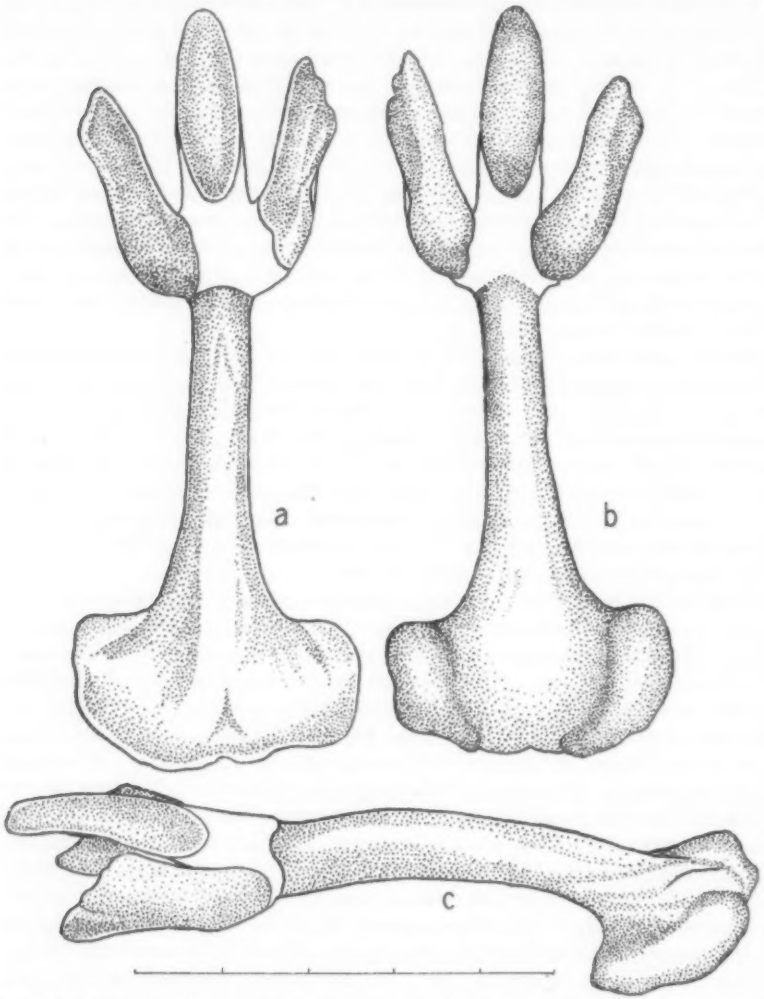

FIG. 2. Baculum of the muskrat, *Ondatra z. zibethica*., a, dorsal view; b, ventral view; c, lateral view. The scale is divided in millimeters.

ened and partially flattened, although the majority that I have examined are smooth as indicated in the illustration. The stalk arises broadly from the dorsal center of the base, assuming a slightly convex course to its distal end. A sharp

dorsal keel occupies the proximal half of the shaft. The shaft is elliptical, with the dorsoventral aspect having the greatest width. The three digitate processes are widely separated from one another and the stalk by connective tissue and cartilage. The median process is the shortest of the three and slightly flattened dorso-ventrally. It arises above the lateral processes. The lateral digitate processes are vertically flattened, widened distally and often scalloped on their free margin. Average measurements of four specimens from adult animals are: overall length, 9.2 mm; shaft, 5.9 mm; basal width of shaft, 3.7 mm; length of median process, 2.7 mm; length of lateral process, 3 mm, greatest width of lateral process, 1.8 mm.

DISCUSSION

Reference to the illustrations will at once show the marked differences in supposedly related genera. This is particularly evident in the disparity of the general appearance between *Synaptomys* and *Lemmus*. On the other hand, the relationship between *Synaptomys* and *Dicrostonyx* is evident when the similarity of the bacula are considered.

Insufficient genera and species are represented to draw definite conclusions regarding the true affinities of the North American microtines. Tentative conclusions may be set forth, however, on the basis of this study.

Among the *Lemmi* group of the Microtinae, *Synaptomys* and *Dicrostonyx* are similar and indicate rather close affinity. *Lemmus helvolus* differs markedly from either of these and should possibly be referred to the group *Microti*. Structurally, it resembles the *Microtus pennsylvanicus* group more closely than does any other material at hand.

The *Microti* group shows considerable variation in the structure of the baculum. The os penis of *Phenacomys longicauda*, with its short digitate processes closely ankylosed to the distal, tri-lobed end of the shaft, is most distinctive and certainly shows no relationship to the *Microti* group. It might well be considered with the *Lemmi*.

Clethrionomys gapperi and *Microtus pennsylvanicus* have rather close affinity to one another. The distinguishing feature of the *Clethrionomys* baculum is the rather prominent spine on the dorsal aspect of the median process; this is occasionally marked in old specimens of *Microtus pennsylvanicus*. The baculum of *Microtus* (*Pedomys*) *ochrogaster* exhibits marked differences from *M. pennsylvanicus* and *Clethrionomys*, notably in the short median digitate process which usually overlaps the distal end of the shaft and the absence or incomplete ossification of the lateral processes, even in old individuals. Structurally, the baculum more closely approximates *Pitymys*, as do also the teeth, number of mammae and plantar tubercles. A closer relationship appears to exist between *M. ochrogaster* and *Pitmys* than between *M. ochrogaster* and *M. pennsylvanicus*. It might properly be accorded full generic rank.

On the basis of the baculum, *Pitymys* more closely approaches the subgenus *Pedomys* than any other genus in the group *Microti*.

Neofiber has a most distinctive baculum, and its relationship to the *Microti*

genera discussed above does not appear to be close. The shape of the shaft and the absence of a median process immediately set it apart. Conversely, *Ondatra*, with which it is customarily associated by systematists, shows a rather close relationship to *Microtus* and little affinity to *Neofiber*. The character of the baculum in *Ondatra* and *Microtus*, other than in size, are quire similar and were it not for the marked external differences between the two, they might be considered only subgenerically distinct.

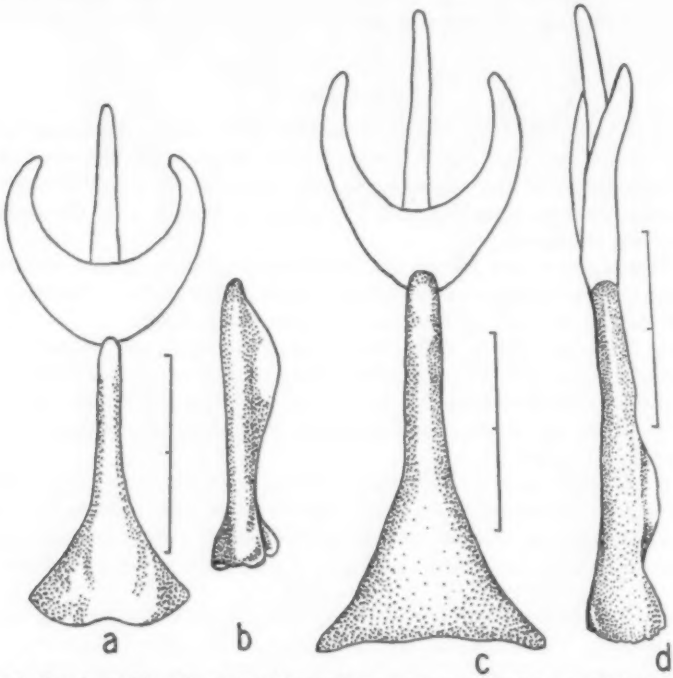

FIG. 3. Bacula of *Sigmodon h. hispidus* and *Oryzomys p. palustris*. a and b, dorsal and lateral view of *Sigmodon*; c and d, dorsal and lateral view of *Oryzomys*. The scale is divided in millimeters.

RELATIONSHIP OF ORYZOMYS AND SIGMODON

These two genera are assigned to the subfamily Cricetinae. *Orzomys*, on the basis of skull and external characters, presumably shows close affinity to the genus *Peromyscus*. The bacula of both *Oryzomys* and *Sigmodon* are so distinctive, differing markedly from *Peromyscus*, *Neotoma*, *Onychomys* and other genera of the Cricetinae which I have studied, that they are herewith described. The prominent three pronged digitate processes, although non-ossified, suggests relationship to the subfamily Microtinae. Sprague (1941) has remarked that on the basis of the hyoid apparatus *Sigmodon* should not be placed in the Cricetinae.

He observes further on the resemblance of the hyoid apparatus of *Oryzomys*, *Sigmodon*, and *Baiomys* among the cricetines.

The baculum of *Sigmodon hispidus hispidus* (fig. 3-a, b) is characterized by a broad flaring base, slightly lobed on the proximal end. Ventrally the base is medially concave. The shaft of the stalk maintains a constant width, narrowing slightly at its rounded distal end. A prominent deep keel forms on the ventral aspect of the distal third of the stalk. The lateral digitate processes are formed by a broad, cartilaginous semi-lunar process having a median width 3.5 times the diameter of the distal tip of the shaft. The median process arises below the base of the lateral processes and extends some distance beyond the tips of these lateral prongs. Measurements of a single baculum from an old male are: overall length, 5.6 mm; length of shaft, 3 mm; basal width of shaft, 1.8 mm; width across lateral processes, 2.2 mm.

The baculum of *Oryzomys p. palustris* is similar to that of *Sigmodon* in its general structure and indicates close relationship (fig. 3-c, d). The digitate processes are strikingly similar in the shape of their cartilaginous prongs, arising and shaping their course like *Sigmodon*. The entire structure is more massive than one finds in *Sigmodon*, the base being broader. Ventrally there is a keel for the greater length of the shaft, although it assumes its greatest prominence on the proximal end of the shaft. Average measurements of 2 adults are: overall length, 7 mm; length of shaft, 4 mm; basal width of shaft, 2.4 mm; greatest width acriss lateral processes, 2.2 mm.

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Department of Zoology, Cornell University, Ithaca, New York.

A MANDIBLE OF MEGALONYX FROM THE PLEISTOCENE OF OKLAHOMA

By Donald E. Savage

The Museum of the University of Oklahoma, Paleontology Division, has in its possession a complete mandible of the Pleistocene ground sloth, *Megalonyx jeffersonii*. This mandible is in a splendid state of preservation and is not distorted.

Table 1.—*Measurements (in millimeters) of mandible and lower dentition of Megalonyx*

	No. 21429 U. S. C.	No. 41-4-S3 Univ. Okla.	M. Jeffersonii (Fig. by Leidy)
Length, anterior end of symphysis to posterior end of angle	287	273	317.52
Length, anterior end of symphysis to posterior end of condyle	264.8	252	—
Depth of ramus below middle of diastema	80.5	74.9	—
Depth of ramus between first and second cheek teeth	86	71	—
Depth of ramus at condyle	122	99.5	107.96
Greatest width across outer sides of anterior teeth	89.6	82.2	—
Width across second cheek teeth	120	83.7	—
Width across outer edge of condyles	161.5	190	—
Length of symphysis along inner side	91	92.2	—
Length of lower dental series, anterior end of anterior tooth to posterior side of last cheek tooth	137.3	128.3	—
Length of lower cheek tooth series	65	63.1	—
Least distance between inner sides of second cheek teeth	19.8	33	—
Anterior tooth, greatest diameter	35.5	35.5	—
Anterior tooth, width normal to greatest diameter	16.5	16.8	—
First inferior cheek tooth, greatest transverse diameter	26.5	23	23.32
First inferior cheek tooth, antero-posterior diameter	18	16.2	18.02
Second inferior cheek tooth, greatest transverse diameter	28.3	25.5	—
Second inferior cheek tooth, greatest antero-posterior diameter	17.8	17.5	—
Third inferior cheek tooth, greatest transverse diameter	26.2	24.9	24.38
Third inferior cheek tooth, greatest antero-posterior diameter	20.7	21.5	18.02

At the present time there exists a scarcity of fossil remains of *Megalonyx;* these few remains have been collected from widely scattered points throughout the United States. The Oklahoma mandible provides further knowledge concerning the geographic range and morphological variations of members of this species.

Megalonyx jeffersonii oklahomensis, new sub-species

Sub-species holotype.—A complete mandible, Mus. Univ. Okla., Paleont. Div., no. 41-4-S3.

Type Locality.—Jack Nelson farm, northeast of the town of Deer Creek, Grant County, Oklahoma. The fossil bearing beds are sand and gravel deposits lying unconformably on Lower Permian red beds.

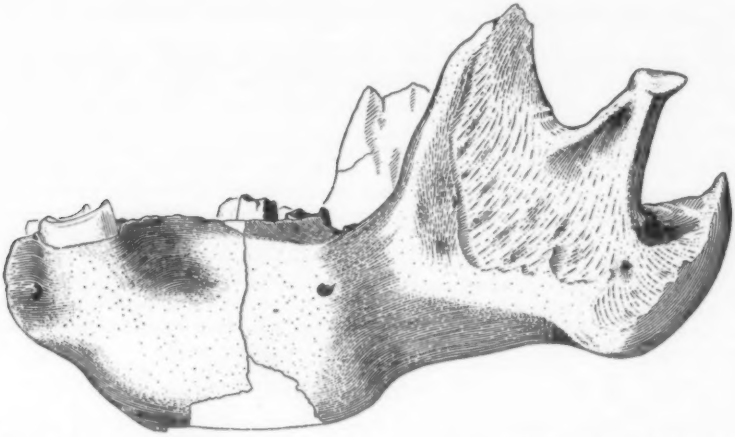

FIG. 1. Lateral view of mandible type of *Megalonyx jeffersonii oklahomensis*, Mus. Univ. Oklahoma, Paleont. Div. no. 41-4-S3. Pleistocene, Grant County, Oklahoma.

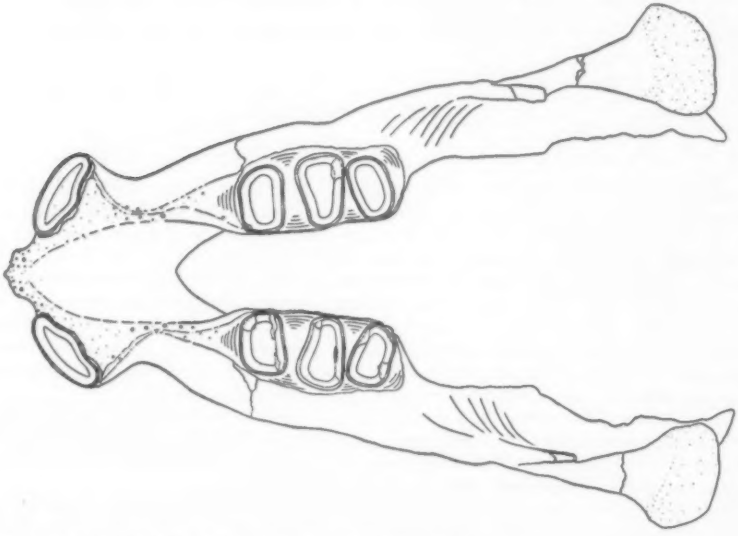

FIG. 2. Occlusal view of same mandible illustrated in figure 1.

Age.—Pleistocene.

Diagnosis.—The features of this mandible conform with the diagnostic characters of the genus and species *Megalonyx jeffersonii* as given by Stock (1925, p. 101). Subspecific characters are: narrow notch between mandibular condyle and angular process; pronounced

mesial and dorsal extension of the angular process; great angle of bifurcation of the vertical rami.

Comparisons.—The Oklahoma jaw has been compared to figures and description of *Megalonyx jeffersonii* as shown by Leidy (1853) and *Megalonyx jeffersonii californicus* Stock (1925, p. 102, pl. 17). The comparative measurements in Table 1 follow the table of measurements given by Stock and by Leidy.

The measurements show that *M. jeffersonii oklahomensis* has a smaller and less massive jaw than both *M. jeffersonii* and *M. jeffersonii californicus*. The Oklahoma specimen also differs from the species holotype and the subspecies *californicus* holotype by the relatively narrow notch between condyle and angular process and by the strong mesial and dorsal protrusion of the angular process. *M. jeffersonii oklahomensis* is also distinct from *M. jeffersonii californicus* because of a much wider separation between the vertical rami. The comparative measurements demonstrate that *californicus* is wider across the anterior cheek teeth and across the second cheek teeth but that *oklahomensis* is much wider across the outer edge of the condyles. The writer concludes that *Megalonyx jeffersonii oklahomensis* had a relatively wide skull as compared to other members of the species.

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Museum of the University of Oklahoma, Paleontology Division, Norman, Oklahoma.

GENERAL NOTES

DISTRIBUTION OF THE PRAIRIE MOLE AND POCKET GOPHER IN ILLINOIS

Accompanying maps show the distribution of the pocket gopher, *Geomys bursarius illinoensis*, and the mole, *Scalopus aquaticus*, in Illinois as recorded in scientific reports and as noted by the writer during the course of a dozen years of biological survey work.

Old records show that the gopher was once more widely distributed than now. A. H. Howell (1910) reported them present in Randolph, Marion, Jefferson, and Richland counties; Charles B. Cory (1912) wrote of having seen one from Macoupin County; and C. H. Merriam (1895) recorded their presence in St. Clair County. Among these counties, gophers have since been observed only in St. Clair, although the writer has looked for them at the other localities. They must now either be much scarcer than formerly or extinct in many localities. These localities are recorded as open circles on the map.

Vernon Bailey (1895) published a map showing the gopher present near Chicago, probably accepting Kennicot's word (1855) for it. Komarek and Spencer (1931) saw a mounted specimen said to have been collected in Champaign County. These records are not shown because the species is certainly extinct in those counties now.

Those localities marked by black dots on the map show where the writer has seen or collected the species since 1930. The great bulk of these localities lie in the crook of the Illinois River, solidly massed as far south as Scott and Macon counties and quite scattered southward from there.

Many localities were reported by the writer (Mohr, 1935) and need not again be reported in detail. A few are of particular interest because of being at the very margins of the gopher's range. County names are in bold-face type. Other names represent localities within 3 miles of which gopher mounds were observed. **Macon**—Boody; **Scott**—Bluffs; **Madison**—Collinsville; **St. Clair**—Belleville and Centerville. The collection of the Illinois

Natural History Survey contains a specimen taken at Collinsville by the writer in 1941.

Moles are more widely distributed than pocket gophers. Specimens have been seen by the writer, or their hills or runways observed, over nearly the entire state. Their range is almost solidly continuous but there are several extensive areas in which they are absent or extremely scarce. Largest of these is the area along the northern tier of counties and extending southward into the second tier, except Jo Daviess County which is solidly occupied. Another, not very evident, includes Douglas County and parts of the counties north and south of it. A third lies in Will County. There are others which have not been investigated thoroughly enough to define.

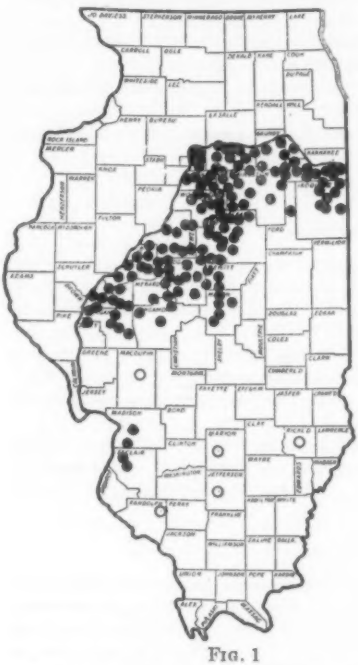

FIG. 1

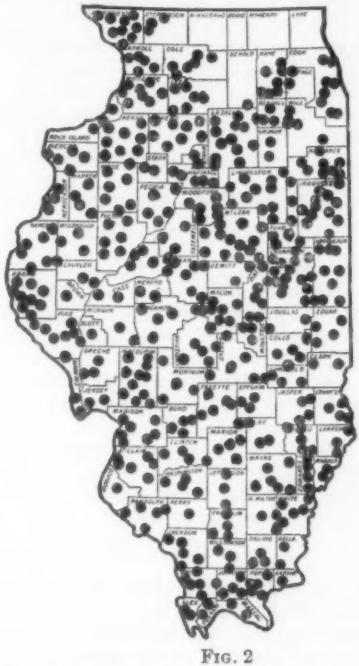

FIG. 2

FIG. 1. Distribution of *Geomys bursarius illinoensis* in Illinois. Present distribution indicated by black dots; open circles are old locality records from which the gopher may have disappeared.

FIG. 2. Distribution of *Scalopus aquaticus* in Illinois.

Offhand, it appears that mole distribution may be correlated with soil types to some extent. They are absent from the centers of the following formations: Pre-Iowan Glaciation in Stephenson and surrounding counties; Iowan Glaciation in Boone and surrounding counties; slate moraines of the early Wisconsin Glaciation; and the slate Wisconsin Glaciation. They are also absent from much of the early Wisconsin Glaciation (without moraines) which occupies part of DeKalb County but are found in that formation elsewhere. It is probable that some, and possible that all, of these formations are habitable and that some associated conditions have prevented moles from occupying them fully. Much of Boone County and parts of the neighboring counties are, for example, low and marshy. Douglas

County, farther south, and parts of neighboring counties are likewise mole-less due to the fact that they were once extensively marshy to swampy. The early Wisconsin Glaciation of which they are largely composed is occupied by moles in other, drier counties.

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CARL O. MOHR, *Illinois Natural History Survey, Urbana, Illinois.*

LEAST WEASEL IN SASKATCHEWAN

On March 12, 1946, we received from the Game Branch, Department of Natural Resources, a least weasel (*Mustela rixosa*) in summer pelage with the exception of a few white hairs on the top of the head and a few white hairs in the tip of the tail. This animal was found under a shock of corn that was being moved on March 9 in the vicinity of North Portal, Saskatchewan. It was taken into North Portal, where, the next day (Sunday) it gave birth to four young. The young were alive when it was shipped to Regina on Monday morning. When we received this animal the young were missing. They had evidently been devoured by their mother.

Mr. Munro Dunbar who forwarded this animal to the Game Branch, has been a resident of the neighborhood for many years. About twenty years ago he caught a least weasel but knows of no other record for that neighborhood.—F. A. DUNK, *Provincial Museum, Regina, Saskatchewan.*

ON THE OCCURRENCE OF A RORQUAL WHALE ON THE TEXAS COAST

On August 17, 1940, a 70 foot rorqual whale was washed ashore on the Texas coast between Freeport and San Luis Pass. Due to the comparative inaccessability of the spot where the whale was stranded, it was not until the next day that any photographs were taken, at which time the local news photographers were out in force and took a number of pictures, two of which appeared in the Houston Chronicle on August 19; three in the Houston Post; and one in the Houston Press.

Dr. A. C. Chandler of Rice Institute examined the beast on the 18th, and identified it, but he does not now remember what his identification was, although he believes that it may have been the blue whale. He did remember, however, that the ventral surface possessed the flutings characteristic of the balaenopterids, and that the color on the sides was somewhat blotched or mottled.

I did not see the animal, then or later, but sometime afterwards I was shown a piece of whalebone purporting to have been taken from the specimen in question. Recently, having become interested in the marine mammals of the Gulf of Mexico, I have made an effort to identify this specimen from the photographs and published accounts, and have accumulated the following data:

Overall length.—70 feet.

Height of spout.—20 to 25 feet (The beast was alive when discovered.)

Whalebone.—Less than 2 feet in length, blue black in color, with the fringe exhibiting traces of yellowish-white along the edges.

Color.—Uniformly dark; sides somewhat mottled. (In one of the photographs the ventral surface appears to be more lightly colored than the rest of the body, although this may be a trick of the lighting).

Dorsal fin.—Of medium height, falcate, and much resembling fig. 37 in True's monograph (Smithson. Contrib. Knowledge, vol. 33, 1904). From its appearance in photographs, it would probably fall within the proportional measurements for the blue whale as given by that authority.

Flukes.—Long, slender, and with moderately recurved tips.

Length of mouth.—As nearly as could be ascertained from an excellent photograph, the length of the mouth, in proportion to the body length, was as 1 to 4½.

Tip of jaw to posterior portion of the pectoral axilla.—Approximately 35% of the total length.

Shape of head.—This agrees closely with the excellent description given by True on page 174 (*op. cit.*).

Pectoral.—Convex anteriorly, although not excessively so. Length, more than 1/9 of total length of animal, but apparently less than 1/7.

Considering everything, I am of the opinion that this was a specimen of *Sibbaldus musculus*, the great blue or sulphur-bottomed whale of Arctic seas and base my conclusions upon the following reasons:

1. Seventy feet is nearly a maximum length for *Balanoptera physalus*, the fin-back whale, and in recent years none has been reported much over 60 feet. On the other hand the reported length is about average for *S. musculus*, although an occasional individual may far exceed it.

2. The proportion of mouth length to body length is that of the blue whale.

3. The jaw to axilla proportional measurement falls within the range of the blue whale.

4. The shape of the head fits True's description almost exactly.

5. Notwithstanding the fact that blue whales have commonly been held to be ice-loving animals, an exceptionally large individual entered the harbor at Cristobal, the northern entrance to the Panama Canal, in January, 1922 (Proc. Zool. Soc. London, pp. 1085–1089, 1927), and others have stranded on the coasts of Florida in May, Virginia in March, and Massachusetts in August (Rept. Smithson. Inst. 1928, pp. 467–494, 1929).

If these data are acceptable, this is the first record of the blue whale in the western Gulf of Mexico.

Incidentally, I know of only one other record of the larger whales from this section. A sperm whale washed ashore at Port Arthur in 1910 (1910, Science, n.s., vol. 31, 631–632, 1910).—J. L. Baughman, *Texas Game Fish and Oyster Commission, Austin, Texas.*

PARTURITION IN A BENGAL TIGRESS

A Bengal tigress (*Felis tigris*) in The National Zoological Park gave birth to a litter of kittens on April 14, 1946. The period of gestation was approximately 113 days, and parturition appeared normal with the exception of the third and last kitten. The mother was unable to expell the youngster although the position was that of a normal anterior presentation. The head and forelegs of the baby protruded, but much straining and labor on the part of the tigress were not sufficient to cause the birth of the animal. It soon became evident that assistance of some kind was needed, and that the baby was dead.

Many wild animals do not allow human interference at parturition. We secured a pole about ten feet in length, to which we made fast a length of stout twine. The pole was introduced into the cage, and the head of the baby secured in a loop. In this manner we pulled, as the mother strained, and the entire foetus, with the placents intact, was removed, thereby probably saving the life of the mother.—Malcolm Davis, *The National Zoological Park, Washington, D. C.*

TWINS IN GREEN GUENON

Twinning in the Old World primate family Cercopithecidae is so uncommon that it is of interest to note the birth of twins to a green guenon, *Cercopithecus sabaeus*, in the San Diego Zoological Gardens on March 18, 1946. The birth occurred sometime during the night and when the keeper arrived in the morning he observed that both babies were apparently dead although the mother continued to carry and clean them. Finally she abandoned the babies at which time the keeper found them to be in a badly bruised condition. Smaller than other green guenons born here, they are believed to have been otherwise normal.

During the past 15 years, more than 40 births of eight different species of *Cercopithecus* monkeys have been recorded in the San Diego Zoo, but this is the first occasion upon which twins have been born here to any member of the genus.—KEN STOTT, JR., *Zoological Society of San Diego, San Diego, California.*

EXTRA TEETH IN A SHREW

Supernumerary teeth in shrews are rare. Hall (Jour. Dental Research, vol. 19, no. 2, pp. 105–106, 1940) found no extra teeth in 1837 specimens of the Soricidae he examined. Jackson (N. Amer. Fauna, no. 51, p. 19, 1928) noted extra teeth in only one of the more than 10,000 examples of *Sorex* available to him.

A specimen of *Sorex saussurei saussurei* Merriam in the University of Michigan Museum of Zoology (U. M. M. Z. No. 88636) has seven, rather than the usual five, unicuspidate teeth in the right upper jaw. In size and amount of pigmentation the two extra teeth resemble the normal third unicuspid. They are located between the fourth and fifth unicuspids, one situated in line with the other teeth, the other arising from the outer (labial) side of the jaw and projecting laterally and ventrally. Associated with the two extra teeth are other modifications in the jaw. The total tooth row is slightly longer on the right side. The first and second unicuspids are normal in position, size and shape, but the third has a smaller crown diameter than its counterpart on the left side and has been squeezed labially, out of line with the first, second and fourth. The fourth is located slightly anterior to its normal position. The fifth is slightly smaller than, and located posterior to, the fifth on the left side. The specimen is a female collected at San Bartolomé, 2900 meters elevation, in Distrito Federal, México.—EMMET T. HOOPER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

NOTES ON ADIRONDACK BEAVER

While hunting deer along the northern outlet of Ferris Lake, Hamilton County, New York, in early November of 1945, I came upon evidence of the use of witch-hobble (*Viburnum alnifolium*) as food by beaver. While it is likely that this shrub has been recorded among the many plants eaten by beaver, a rather hasty review of the literature failed to disclose any record of its use by this animal.

These observations pertain to a beaver pond about one-half mile west of Ferris Lake. The pond, some 20 acres in area, is impounded by a dam about four feet in height. The neighboring slopes, which rise at a rather steep angle from the shores of the pond, support a mature forest composed primarily of yellow birch, sugar maple, and spruce; red maple, beech, balsam fir, and hemlock occur in lesser numbers. There is an understory made up of the reproduction of these species, particularly yellow birch, the maples, and spruce. In addition, there is a considerable amount of witch-hobble. The fact that aspen was formerly abundant in the vicinity of the pond is attested by the presence of the old stumps; however, the beaver have long since exhausted the supply of this preferred food.

The only signs of recent cutting were on the south side of the pond, about one-third of the way from the dam toward the inlet. Here a considerable number of witch-hobble stems up to one inch in diameter, as well as several red maples of slightly larger size, had been cut. The stems had been dragged to the pond and presumably added to the winter food cache. There was no visible evidence of recent repair work on the dam. Since I did not walk com-

pletely around the flooded area, it is quite possible that the cutting of trees or shrubs of other species was overlooked.

There were resident beaver in this pond on the occasion of my first visit in the fall of 1929. On each of five return trips at irregular intervals since that time, fresh beaver signs have been present. However, I am unable to state with certainty that occupancy of the pond by beaver has been uninterrupted during these seventeen years.—CHARLES P. BROWN, *Wildlife Research Center, Delmar, New York.*

RE-ALLOCATION OF THE TOWNSEND GROUND SQUIRREL

In the pursuit of any investigations in natural science, specialists sometimes differ one from another in method of approach with conclusions that are likewise at variance. From this premise we wish to present the case of the transfer of the name Townsend ground squirrel (*Citellus townsendii*) from populations on the east side to the west side of the Columbia River in southeastern Washington.

The name was proposed by Bachman in 1839, but the location of the type locality has been more recently disputed, with resulting confusion in published accounts of ground squirrels in this region. The unspotted species of *Citellus* west of the Columbia was long recognized as *C. mollis yakimensis*. The squirrels east of the broad Columbia River are spotted. And thereon hinge point values for making the transfer—which was reluctantly accepted by the present writer in a former article for this Journal (vol. 22, no. 3, pp. 270–279, 1941).

The type specimen of the Townsend ground squirrel was collected by Dr. J. K. Townsend in 1836 and was described by Bachman three years later. Townsend and Nuttall (both names to conjure with in natural science) had traveled overland to the Pacific coast in 1834, sponsored in their biological explorations by the Philadelphia Academy of Natural Sciences. In the summer of 1836, some months previous to Townsend's heading back toward the East by water, he spent several weeks exploring and collecting from headquarters at old Ft. Walla Walla, or the Mission there. Arriving on the evening of July 6, he may have collected the type in question on a trip he reports the next day on the "West side of the little Walla Walla River," and certainly east of the Columbia River. As these squirrels are seldom seen out of aestivation later than the first week in July, Townsend was rather fortunate in finding a squirrel on either side of the Columbia at this date, and the chances of collecting one would have been much less when he crossed the river again to the west side on his return to Fort Vancouver considerably later. Furthermore, Townsend did not mention in his journals any collecting trip west of the broad river, but confined his narrative to the Walla Walla region and the Blue Mountains to the south.

In several years of field study of the small mammals in the Four Rivers country of eastern Washington, we have never seen a spotless ground squirrel east of the Columbia River, nor a spotted one west of the river.

In due course of time the (type) squirrel from the Columbia arrived at the museum of the Philadelphia Academy of Science and was accessioned as no. 344, there to repose for one hundred years as representative of the spotted species east of the Columbia; part of the time at least as an exhibit mounted in the approved fashion of the day. But finally there was need for revision of the group, and at this time his pelage markings were given, as I view it, undue prominence. The old skin was immersed and washed in petroleum ether and, after drying, it *appeared* to be immaculate (faded?). Anyhow there were no spots on the pallid skin—and the species had found a new type locality *west* of the Columbia River, after a century of masquerading as a spotted squirrel from the *east* side. *Citellus mollis yakimensis* thus lost its identity entirely and the east-side species (spotted) was renamed *Citellus washingtoni*. But Audubon and Bachman, one of whom at least had seen the type specimen in its youth, state that it is "speckled with white all over the back"! One sure way of settling the question is to examine the skull of the specimen handled by Bachman if it is still available. This appears not to have been done.

If there is a moral to this tale of two squirrels it may lie in the suggestion that mam-

malogists should strive for an authorative Check List that will be comparable in a way to the A.O.U. of ornithologists.—THEO. H. SCHEFFER, *Puyallup, Washington.*

MONTANA RECORDS OF BEAVER EMBRYOS[1]

In the spring of 1942, several beavers were collected by wardens of the Montana Fish and Game Commission, and the uteri of females sent to Montana State College where they were preserved by the late Prof. M. H. Spaulding. Recently, these specimens were examined by the writer and it is believed that the following observations are worth recording.

Eleven uteri were available with complete collection data except that one lacked the date of collection. The data on the eleven are presented in Table I. The weights are of preserved specimens.

TABLE 1.—*Data on beaver embryos collected in Montana in 1942*

DATE	LOCATION	TOTAL NO. EMBRYOS	♂ EMBRYOS	♀ EMBRYOS	AVE. WT. GRAMS	AVE. WT. ♂ GRAMS	AVE. WT. ♀ GRAMS	CROWN-RUMP LENGTH MM.
Mar. 21	Rocky Creek, Gallatin Co.	5	1	4	7.0	7.7	6.8	48
Mar. 25	Bitterroot R., Ravalli Co.	4*	3	—	180.3	180.3	—	140
Apr. 3	Rocky Creek, Gallatin Co.	6*	4	1	6.4	7.3	6.2	45
Apr. 10	Squaw Creek, Gallatin Co.	2	2	0	22.7	22.7	—	65
Apr. 11	Squaw Creek, Gallatin Co.	3	2	1	23.0	23.7	21.5	70
Apr. 13	Dillon, Beaverhead Co.	4	1	3	142.2	142.5	142.1	120
Apr. 13	Dillon, Beaverhead Co.	3	1	2	182.3	181.5	183.0	145
Apr. 16	Dry Creek, Gallatin Co.	7	2	5	194.8	207.5	189.7	200
Apr. 16	Dry Creek, Gallatin Co.	3	1	2	277.1	287.0	272.0	235
May 7	White Sulphur Spr., Meagher Co.	5*	4	—	458.5	458.5	—	275
—	Rocky Creek, Gallatin Co.	3	1	2	101.4	94.8	104.7	142
		49	21	25				

* Discrepancies between total number of embryos in a litter and the number of males and females are due to lack of opportunity to sex certain embryos.

Based on weight the following approximate developmental stages were noted:

1. *Six gram embryo.*—Hairless, but papillae evident, especially those for facial vibrissae; mammae evident on both sexes; sexes readily distinguished by dissection; testes abdominal; nails evident on front feet but not on hind feet; teeth not erupted; mouth and cloaca open; tail rounded.
2. *Twenty-three gram embryo.*—Similar to above but with hind claws apparent.
3. *Eighty-two gram embryo.*—Similar to the first stage but with hair papillae much more evident. These embryos do not appear in the table.
4. *One hundred and two gram embryo.*—No hair on body; vibrissae on snout 2–3 mm; hair of eyebrows 2–3 mm; tail flat rather than rounded.
5. *One hundred and forty gram embryos.*—Small hairs on head and shoulders but not on rump or sides.

[1] Contribution from Montana State College, Agricultural Experiment Station. Paper no. 65 Journal Series.

6. *One hundred and eighty gram embryo.*—Testes as far posterior as possible in abdominal laterad and adjacent to the intestine in the perineal region; caudal epididymis of each appears to be in a peritoneal sac; very sparse hair on the hindquarters; vibrissae on snout about 5 mm long.
7. *Two hundred and seventy gram embryos.*—Head and shoulders well haired but the rest of the body sparsely haired.
8. *Four hundred and fifty gram embryo.*—Testes in pseudopockets on either side of perineal region but in abdominal cavity except possibly the caudal epididymis; fully covered with long dark brown hair; light greenish material in lower gut. According to Packard (Jour. Mamm. vol. 22 p. 89) and Bradt (Jour. Mamm. vol. 20 p. 487) these embryos must have been fairly close to full term.

All the beavers except one were collected on the headwaters of the Missouri River at elevations ranging from 4,800 to 6,000 feet. The exception was taken from the Bitterroot River, at an elevation of 3,300 feet, on the Pacific side of the continental divide. This river is a part of the Columbia River drainage. The embryos from this female are at variance, considering the date, with those from the Missouri. However, this is probably not significant as Scheffer (Jour. Mamm. vol. 6 p. 129) recorded embryos from the Columbia River in Oregon in March and April which correspond in size with the present records from the Missouri.

A total of 49 embryos were obtained or 4.08 per female, with a maximum of 7 and a minimum of 2. Of the 46 embryos available for sexing, 21 were males and 25 were females, not a significant deviation from a 50:50 ratio by the chi-square test. This corresponds with the data obtained in Michigan by Bradt (Jour. Mamm. vol 19 p. 152).

No external differences in sex were discovered and all embryos were sexed by dissection. From the data there does not appear to be any significant difference in the size of female and male embryos. There was, however, a notable variation in the weights of littermates. The considerable variation in weight between litters taken from the same general location indicates a fairly long mating season.—CLARENCE ARCHER TRYON, JR., *Department of Zoology and Entomology, Montana State College, Bozeman, Montana.*

AN INTERESTING FEEDING HABIT OF SKUNKS

The habit of some mammals, large and small, of following rather definite paths or trails during their routine comings and goings is well known. Particularly is this true of the skunk (*Mephitis mephitis nigra*), and especially in rather heavily forested areas, where they habitually use deer trails, abandoned roads, footpaths and other linear openings. While working at the Roosevelt Game Preserve, Scioto County, Ohio, in 1936, I often collected scats of skunks from trails for use in food habits determination. During the summer, it was noticed that a large number of carrion beetles of the genus *Necrophorus* were being eaten by skunks and appearing in the scats. It was also found at about the same time, that these carrion beetles were being attracted to the scats of skunks, opossums, deer, and other animals using the trails. On the 23rd of August, a skunk was observed on a well-beaten deer trail examining the scats and feeding on various insects, including butterflies and the previously mentioned carrion bettles, both present in considerable numbers. These skunks had found an easy method of obtaining food, simply by "running a line" of scats at intervals during the day. It is also significant that the blueberries, dewberries, and other fruits found in the summer diet of skunks are best developed and fruit more abundantly along trails and other openings in the forest.—FLOYD B. CHAPMAN, *Ohio Division of Conservation, Columbus, Ohio.*

TWO GENERA OF POCKET GOPHERS SHOULD BE CONGENERIC

Pocket gophers of the genera *Cratogeomys* and *Platygeomys* are no more distinct from each other than are gophers of several species of *Thomomys*, for example, *T. bulbivorus* and *T. bottae* or *T. townsendii* and *T. talpoides*. The structural differences between the two genera are sufficient in amount and kind for characterizing species groups, but in my

opinion inadequate for differentiating genera of pocket gophers. Then, too, if the two groups are treated as congeneric, their close connection is indicated. This is in harmony with the primary function of the genetic category, namely, to show close relationships of forms included therein. For further consistency, other genera of Mexican and Central American gophers, *Orthogeomys*, *Heterogeomys*, *Macrogeomys*, *Pappogeomys*, *Zygogeomys*, and *Geomys*, should be compared critically in light of modern taxonomic concepts for similarities warranting genetic grouping.

Below are given data which led to the conclusion that *Cratogeomys* and *Platygeomys* should be treated as congeneric. Morphological features employed by Merriam (N. Amer. Fauna, no. 8, 1895) in his review of the family Geomyidae (exclusive of the genus *Thomomys*) were used by me primarily in the comparison of specimens of *Platygeomys* and *Cratogeomys* as follows: *Cratogeomys merriami:* Distrito Federal: Ajusco, 2 (U. S.); Tlalpam, 4 (U. S.). México: Monte Río Frío, 2. *C. castanops:* Texas: Jeff Davis and Brewster counties, vicinity of Davis Mountains, 10; Dawson County, 2; Lubbock County, 3. *Platygeomys gymnurus:* Jalisco: Zapotlan, 3 (U. S.). *P. tylorhinus:* Hidalgo: Tula, 3 (U. S.). *P. planiceps:* Distrito Federal: Mexico City, 9; Coyoacán, 3. México: Volcán Toluca, 2 (U. S.). *P. varius:* Michoacan: vicinity of Uruapan, 14; 1 mi. S Corupo, 2. Specimens indicated by the symbol (U. S.) are from collections of the U. S. Fish and Wildlife Service. For their use I thank Hartley H. T. Jackson.

The two groups of specimens (*Platygeomys* and *Cratogeomys*), supplemented with data from Merriam (*ibid*), are compared below:

Platygeomys	*Cratogeomys*
Color reddish-brown or blackish.	Color reddish-brown, tan, or blackish.
Pelage moderately dense and soft.	Pelage moderately dense and soft.
Size medium (*fumosus*) to large (*gymnurus*)—hind foot 37–52 mm.	Size medium (*castanops*) to large (*merriami*)—hind foot 31–51 mm.
Pm^4, M^1, and M^2 without posterior enamel plate.	Pm^4, M^1, and M^2 without posterior enamel plate.
Single median sulcus in upper incisor.	Single median sulcus in upper incisor.
Greatest breadth of skull across squamosals 93–107 percent of zygomatic breadth. Depth of cranium at occiput 37–47 percent of breadth across squamosals.	Breadth 89–97 percent of zygomatic breadth. Depth of cranium at occiput 46–49 percent of breadth across squamosals.
Lambdoidal crest sinuous.	Lambdoidal crest broadly convex (*merriami*) or sinuous (*castanops*).
Greatest breadth of mandible about equal to or greater than length.	Mandible slightly longer than broad.
Angular process long, moderately narrow.	Angular process shorter, broader.
Lower incisor root located about midway between condyle and angular process.	Lower incisor root located nearer angular process than condyle.
Shelf present around base of incisor root.	Shelf present around base of incisor root.
Jugal forms much of zygomatic arch, its length anterior to squamosal arm of zygomata amounts to 57–101 percent of length of basioccipital on median line. Jugal expanded anteriorly into broad plate.	Jugal forms much of arch, its length anterior to squamosal arm of zygomata amounts to 53–74 percent of length of basioccipital. Jugal expanded anteriorly into broad (*merriami*) or small (*castanops*) plate.
Paroccipital process large, flattened dorsoventrally.	Paroccipital process large, flattened dorsoventrally (*merriami*), or small, without plate (*castanops*).
Length of cutting edge of upper incisors 13–15 percent of basilar length.	Length of cutting edge of upper incisors 14–18 percent of basilar length.
Anteroposterior and right-left diameters of incisors subequal.	Anteroposterior and right-left diameters of incisors subequal.

The differential characters to be seen in the sphenoids, turbinals, and ethmoids and in the area about the auditory capsule (Merriam, *ibid*) are variable and slight, not of generic weight.

Of the several characters employed by Merriam for differentiating *Platygeomys* and *Cratogeomys*, those pertaining to the shape and dimensions of the zygomata, brain case and mandible are the principle ones. Those characters as a lot will distinguish the two groups, but individually they may be more or less common to both groups. For example, in *Platygeomys* the skull is usually broadest posteriorly. However, in 14 of the 16 specimens of *Platygeomys varius* at hand the breadth of the skull across the squamosals is less, rather than more, than the zygomatic breadth. There is also slight overlap between the groups in size of the jugal, depth of the cranium, and length and breadth of the mandible.

All of the differential characters are of a sort and magnitude which in the genus *Thomomys* and in some other small mammals are employed to differentiate species or species groups, not genera. In summary, study of specimens of *Cratogeomys* and *Platygeomys* indicates that those two groups of gophers are closely related and should be included within one genus. The latter group should be treated as the *platygeomys* group of the genus *Cratogeomys*, which name takes precedence for the genus through page priority (Merriam, *ibid*).—

EMMET T. HOOPER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan*

REVIEWS

Cooley, R. A., and Glen M. Kohls, THE GENUS IXODES IN NORTH AMERICA. Nat. Inst. Health, Bull, no. 184, 246 pp., 87 text-figures. Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C. Price 40 cents.

This monograph of the genus *Ixodes* is the fourth of a series of monographs on the ticks of North America by the same authors. The genera *Dermacentor, Amblyomma*, and the family Argasidae have been treated previously.

Most of the 41 species of *Ixodes* listed are parasites of mammals but a few are typical bird parasites. Several species bear the name of their respective mammal hosts, as *I. neotomae, I. peromysci, I. marmotae, I. ochotonae, I. muris, I. soricis*, and *I. conepati*. Four species are recorded from man.

Synonymy, description of adults and immature stages, where known, host and geographical distribution, line drawings, and distributional maps are given for each species. A classified list of vertebrate hosts records the species taken on each.—WILLIAM L. JELLISON.

Schaldach, William J. CARL RUNGIUS. Big Game Painter. Fifty Years with Brush and Rifle. Countryman Press, West Hartford, Vermont. Pp. [10] + 1–117, 10 col. pls., portrait, 11 phot., 18 drawings, 9 etchings. Quarto. 1945. Price $17.50. Sold by A. S. Barnes & Co., 67 West 44th St., New York 18, N. Y.

So few are the really top notch painters of big game in any country, a book about one of them is an important item for the naturalist. Carl Rungius is, by far, the most accomplished and successful exponent of this difficult branch of art that we have had in North America.

The artist was born near Berlin, Germany, in 1869. He attended art school there and, at an early age, did excellent drawings of mammals. He first came to this country in 1894 to hunt moose in Maine and returned to stay in 1897. His career has not been easy, and he earned a living by illustrating before turning to serious painting. In the latter field, experience has taught him that animal *art* is somewhat in disrepute here (as compared to abroad where such painters are solicited for important exhibitions) because of the flood of cheap posters and advertising illustrations. From his attempts to enter important exhibitions, Rungius has found that the judges and critics, not understanding animal painting, feel that this kind of subject matter is not serious art. As proof of this point, he painted landscape for a while, taking an important prize with one such picture and being elected to the National Academy!

The artist's methods are of interest. His drawings are very sure and solid. All those in

the present book were done prior to about 1915, although many of the other illustrations are more recent. Smaller game, such as pronghorns or sheep, has been shot and then set up in normal postures, by means of ropes, and sketched and studied from all angles. Larger game has been sketched where it fell, with a great many studies made of heads. Under such conditions, a sudden change to warm or rainy weather can be ruinous to freshly killed game, or the opportunity to sketch it. He uses the camera a great deal, as a quick way of making a record of the specimen or landscape. In later years his field sketches have been done directly in oil paint—to get an accurate color record of the subject in outdoor light. When flies are numerous, he has had to remove their dead remains from oil sketches by means of forceps.

Some of Rungius' best work is owned by the New York Zoological Society. These pictures were purposely made somewhat 'scientific,' in that the subjects are at ease in open spaces and with the feet visible. The illustrations in the present book are more spontaneous—as though one suddenly came upon a grizzly in down timber, or spotted some pronghorns on a ridge covered with sagebrush. The artist has worked chiefly in Wyoming, New Brunswick, Alaska, and Alberta. Part, at least, of 35 different years has been spent in the Canadian Rockies. I doubt that many men in the past 50 years have legally killed more North American big game than he has.

Those of us who have seen the stacks of field sketches in one of Rungius' studios would prefer a volume or two of sketches only, with the artist's comments about each one. Similar studies can never be done again in many cases, such as those of woodland caribou in New Brunswick and some of the Wyoming material. The present volume is fairly well written, with an eye to the sportsman. It seems free of errors, although I note a conflict of dates on page seven. I question the statement (pp. 8–9) that Sweden was so solicitous of Liljefors, the great animal painter, that his works were not allowed out of the country except on loan. Considering the quality of the reproductions, paper, and printing, the high price of this book seems justifiable. A less expensive trade edition is forthcoming, however, as soon as paper is again plentiful.—Ralph S. Palmer.

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)
[Reprints of this section may be purchased from the Corresponding Secretary]

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——— One impressive way nature takes care of surplus game animals. North Dakota Outdoors, Grand Forks, vol. 8, no. 6, p. 7, illus. December, 1945.

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COMMENT AND NEWS

REPORT OF THE AMERICAN COMMITTEE FOR INTERNATIONAL WILDLIFE PROTECTION ACTIVITIES FOR THE SOCIETY OF MAMMALOGISTS, PITTSBURGH, 1946

This is the first time since 1941 that I have been able to render a report of my stewardship as your representative on the American Committee for International Wildlife Protection under the chairmanship of Mr. Childs Frick. The Committee is now in its 16th year of struggle with what Dr. Gregory so aptly terms the "most destructive of all placental mammals".

The war years have marked the highly satisfactory completion of two projects which the committee has been working on for a number of years. I refer to (1) the final publication and distribution of the Harper-Allen volumes on Extinct and Vanishing Mammals of the World, (2) the entrance into force of the Convention on Nature Protection and Wildlife preservation in the American Republics, together with the establishment of a Conservation Section in the Pan American Union to help implement this Convention under the able direction of Mr. William Vogt. I will deal more fully with these subjects below.

Also during the war our Committee initiated and sponsored a highly important project known as the Pacific World Series, executed under the Captaincy of Fairfield Osborn, President of the New York Zoological Society, together with a most able publication team. Six books were written for and distributed to men of our armed services in the Pacific, giving them basic and accurate information on the Pacific World in general (a composite volume), and on Native Peoples, Plants, Insects, Fishes and Shells, Reptiles, and Mammals.

The Committee has suffered an irreparable loss in the death of Thomas Barbour who was closely associated with many of its activities since its founding. He made two trips to South Africa for us in the summers of 1934 and 1935 to look into the status of the last surviving Bontebok, Addo bush elephant, white-tailed gnu, mountain zebra, South African white rhinoceros, and Cape hartebeest. In this connection we had word in 1943 from our associates in the Wildlife Protection Society of South Africa that Dr. A. Seele bought the farm in Natal where the last remnants of true *Bubalus caama* survive and he will protect them there.

Our Committee suffered a special loss in the death of Lord Onslow who for many years had been the guiding light of the Society for the Preservation of the Fauna of the Empire and the prime mover in putting through the London Convention for the protection of the Fauna and Flora of Africa.

The end of the war brings renewed contact with the founder of the International Nature Protection movement Dr. Peter Van Tienhoven of Holland who with his unbounding energy and enthusiasm for the cause asks for news of the outside world and has started to rebuild his active Dutch society. Dr. Van Straelen of Belgium is expected over here shortly. His Institute for the Parks of the Belgian Congo has published a number of special monographs on the Congo Park collection made prior to the war and he and Dr. van den Berghe have plans for a new scientific institute for research in Central Africa that may be located near Baraka, on Lake Tanganyika. It will be an international research center of great help to all kinds of researchers with field problems in Central Africa.

Gorillas.—One of the duties of the American Committee is to serve as a watch dog in matters of enforcement of International Conventions for the protection of vanishing species. In 1941 eight young gorillas were brought in to New York by dealers and reports reached us on the slaughter of numbers of gorillas in French Equatorial Africa in the capture of considerable numbers of animals for export to this country. This violation of the spirit of the London Convention was called to the attention of the French authorities and I am pleased to report that the Commissioner of Colonies took prompt and effective action to see that no more such permits would be granted in French Equatorial Africa, and that such incidents would not be repeated.

Harper-Allen report.—The late Glover Allen prepared the new world volume of the report on Extinct and Vanishing Mammals. He also dealt with the oceanic mammals and his volume which was published in 1942 runs to some 620 pages.

The compilation and evaluation of basic knowledge of the Extinct and Vanishing Mammals of the World (within historic times) proved to be a large undertaking. Dr. Francis Harper who undertook the assignment back in 1936 was eminently suited for the job. He was not only an experienced mammalogist but also a meticulous worker. Through his wide acquaintance with the literature and zoologists both in this country and abroad he was able to assemble a great deal of material, and often found himself snarled in problems of nomenclature of even some of the largest and best-known of the Old World mammals. He was well qualified to straighten these out in two preliminary papers which preceded the publication in 1945 of his 850 page volume on Extinct, Vanishing or Threatened Mammals of the Old World. In this volume he discusses in detail some 400 forms and summarizes the entire subject. The Committee feels that with the Harper-Allen volumes the corner-stone has been laid for the building of future plans for the preservation of vanishing mammals in their native habitats from threats of total extinction.

According to Dr. Francis Harper, during the past 2000 years the world has lost through extinction about 106 forms (species or subspecies) of mammals. Distributed by regions as follows: Australia 11; Malay Archepalego 3; Asia 3; Europe 6; Africa 9; Madagascar 1; North America 27; West Indies 41; South America 1; Falkland Islands 1; Galapagos Islands 2; oceans 1. About 67% of these losses have been in the last century and 38% during the past 50 years, which shows that the rate of extinction is being accelerated.

The American Committee wants your help in stopping it. Our way to give this assistance is to see that all schools and colleges drive home the importance of conservation to their student classes. The Harper-Allen volumes can be procured from the Secretary of our Committee at the Zoological Society, the Bronx, New York City.

Our Committee would like to see similar volumes on Extinct and Vanishing Birds and also Reptiles, Amphibians and Fishes.

Pan American Convention.—The Convention on Nature Protection in the American Republics came into force on May 1, 1942. Eighteen of the Republics have signed it and it has been ratified and is in force for the United States, Guatemala, Venezuela, El Salvador, Haiti, the Dominican Republic, Mexico, and Ecuador. This Convention establishes a

basic pattern for a scheme of parks and reserves through the Americas on a basis that experience has shown is thoroughly sound. It calls for appropriate protective laws for threatened flora and fauna and favors cooperation in scientific field studies, the protection of migratory birds, the protection of vanishing species, and the control of contraband fauna and flora protected by the laws of other countries.

The newly established section of Conservation in the Pan American Union under Dr. Vogt has already made conservation surveys in Chile, Mexico, and Guatemala. A new section has been established in the Mexican Ministry of Education, and a two year wildlife survey of Mexico is under way. Mexico is faced with serious problems due to hunting, grazing, and wood cutting in her National Parks with insufficient numbers of forest guards. This results in a shocking situation due to general apathy and lack of public education and appreciation of the importance of maintaining parks inviolate.

Due in large measures to Vogt's activities, the Pan American Union is convoking a Congress in June 1947 to consider the problem of the protection and better utilization of this hemisphere's renewable resources. Over grazing, forest destruction, and erosion are serious problems in many latin American countries.

State Department—Fish and Wildlife.—On October 11, 1945, the American Committee officially wrote the Department of State listing eight international treaties and conventions to which our government had pledged its support. We pointed out that the proper enforcement of these treaties, agreements and conventions, the study of proposed modification, and the initiation of additional international cooperation in this field was a matter of primary concern to our government, the burden of which rested with the Department of State. We also referred to a letter sent in by John Baker on a similar subject on August 21, 1944, from the National Audubon Society:

The Committee expressed the hope that there should be established in the Department of State an Office of International Conservation Policy to coordinate all information on these subjects and after consulting the appropriate agencies of the government to recommend policy and appropriate action.

I am pleased to report that on March 1, 1946, a Fish and Wildlife Branch was established in the International Resources Division of the Department of State and given the responsibility for: "formulation and coordination of policy and action in international fisheries and wildlife matters and agreements." The Director of this new activity is Dr. Fleury who has had experience in dealing with such matters.

Pacific Conservation.—The American Committee is actively engaged in efforts to encourage the protection of threatened island species in the vast Pacific area. The war with its inevitable destruction from explosives, clearing of land, spraying with powerful insecticides, amateur hunters, and even foreign wildlife introduction has done irreparable damage to some Pacific species. It is urgently necessary that adequate laws, as well as parks and reserves be established immediately in the American controlled islands. It is also important to carry out as soon as possible surveys of the habitats of rare species to determine if steps can be taken to assure their survival. In early June the National Research Council is calling in Washington a Pacific Science Conference to help in the development of plans for Pacific research in cooperation with government agencies and private foundations. Conservation may very well be discussed at that meeting and possibly a permanent organization to coordinate research in Pacific areas will be established. The past Pacific Science Congresses have made important recommendations in the conservation field and the Dutch, the New Zealanders, and the Australians had made important progress in the years before the war.—HAROLD J. COOLIDGE.

LETTERS TO THE EDITOR

SPECIAL WILDLIFE AREAS IN UNITED STATES NATIONAL FORESTS

DEAR SIR:

The number and types of areas which the United States Forest Service has set aside to protect native floras, faunas and recreational values and the administrative policies which pertain thereto should be familiar information to most students of natural history and others interested in wildlife in the United States. I doubt, however, that many individuals of this group, who are not employed in a service concerned with administration of such areas, are familiar with the wilderness program of the Forest Service and know, for example, the distinction set by the Service between Wilderness, Wild, and Primitive areas under their jurisdiction. Certainly in many discussion groups composed of students of field biology, questions raised regarding such areas remained unanswered. It seems worthwhile, therefore, to review information about such areas which has recently come to hand. Much of the material given below is provided under date of May 6, 1946, by the Chief of the Forest Service in his acknowledgement of receipt of those resolutions concerned with preserving the wilderness which were passed by the American Society of Mammalogists in annual meeting on April 20, 1946.

The Forest Service administers nine classes of areas wherein the preservation and protection of floras and faunas is an administrative aim. In some, rigid protection is desired. In others, protection and preservation of native kinds is secondary and the areas may be rather freely modified and trampled. Quoted passages below are copied directly from data supplied by the Chief. A description of the classes of areas follows:

(1) *Wilderness Areas.*—"A wilderness area is an area characterized by primitive conditions of transportation and habitation. It contains no provision for the passage of motorized transportation and excludes hotels, resorts, summer homes, and commercial logging. The minimum size which will be recognized as a forest wilderness is 100,000 acres. The boundaries of a wilderness will always be at least one-half mile back from the centerline of any route for motorized transporation. These areas are established by the Secretary of Agriculture under Regulation U-1 of the Secretary."

There are now four Wilderness Areas, totaling 1,507,466 acres, located in three states, Arizona, Montana, and Oregon.

(2) *Wild Areas.*—"A wild area is of the same character as a wilderness area, but is less than 100,000 acres, although at least 5,000 acres in size. Areas of this character are established by the Chief of the Forest Service under Regulation U-2 of the Secretary of Agriculture."

There are nine Wild Areas with an area of 329,243 acres in four states, Arizona, New Mexico, Oregon and Washington.

(3) *Roadless Areas.*—"In some cases where wilderness areas would otherwise be desirable, economic values are too great or other considerations make such a designation impracticable. It still may be desirable and feasible, however, to exclude permanent roads from the area, thus preserving many of the wilderness values but allowing utilization of the timber or other resources by means of temporary roads unsuitable for ordinary motor travel. Such areas may be designated under the provisions of Regulation U-3 of the Secretary of Agriculture."

Only three such areas have been established to date. They have a total area of 1,082,300 acres. All are in Minnesota.

(4) *Primitive Areas.*—"A primitive area is an area characterized by primitive conditions of environment, transportation, habitation, and subsistence. Such areas were set aside by the Chief of the Forest Service under Regulation L-20 of the Secretary of Agriculture and the areas now classified as primitive areas will be reexamined by the Forest Service in the light of the new regulations and those areas which qualify on the basis of characteristics, local conditions, and public approval will be classified as wilderness or wild areas under Regulation U-1 or U-2."

As indicated above, these areas are being reviewed for reclassification and the number of them is being reduced. At least three have recently been revoked or reduced in size. At present there are fifty-nine Primitive Areas, located in ten western states, and totaling 11,450,399 acres.

(5) *Natural Areas.*—"Natural areas are areas set aside to be permanently preserved in an unmodified condition representative of the virgin growth of each forest or range type within each region so far as they are represented within the national forest, to the end that its characteristic plant and animal life and soil conditions, and the factors influencing its biological complex shall continue to be available for purposes of scientific study, research, and education."

There are forty-eight Natural Areas, aggregating 62,190 acres, in twenty-one states and Alaska.

(6) *Vanishing Species Areas.*—"Vanishing species areas are areas set aside by the Chief, Forest Service, for the perpetuation and protection of rare or vanishing species of plants or animals."

Four such areas have been established, one each in California and Washington and two in Oregon, with a total of 17,990 acres.

(7) *Recreation Areas.*—"A recreation area is an area other than wilderness or wild areas which should be managed principally for recreation but on which certain other uses may or may not be permitted. Areas in excess of 100,000 acres are approved by the Secretary of Agriculture; areas of less than 100,000 acres are approved by the Chief, Forest Service, or by such officers as he may designate. These areas are established under Regulation U-3 of the Secretary of Agriculture."

There are eight Recreation Areas, located in seven states and Alaska, and totaling 16,037 acres.

(8) *Federal Refuges in National Forests.*—"Federal game refuges, preserves, and sanctuaries in the National Forests are established by or under the authority of acts of Congress. These refuge areas have been set aside to provide for protection and restoration of wildlife and as part of a program to develop the wildlife resources on the National Forests. As wildlife species become plentiful in the refuges they may be captured and used for stocking National Forest and other areas. Where this is not feasible or necessary, the refuges can be opened to hunting or fishing under regulations of the Secretary of Agriculture. Permits are limited to the number of persons needed to remove the surplus fish and game populations, and the utilization programs are developed in cooperation with the States."

Twenty-five such preserves have been established, located in 13 states, and composed of 1,434,314 acres.

(9) *Experimental Forests and Ranges.*—"Experimental forests and ranges are areas made permanently available for silviculture, range, products, economics, influences, and other related forest research. They are carefully selected and represent as fully as possible conditions in important parts of forest regions and large enough to meet present and foreseeable future needs. In essence these areas are field laboratories for intensive investigative work."

There are 89 of these experimental areas located in thirty-two states and Porto Rico. They have a total area of 856,867 acres, of which about 83.5 per cent are Federal lands, 11.5 per cent are state lands, and 5 per cent private lands.

Because there are these several classes of special areas in the National Forests which embody varying degrees of protection and perpetuation of the native faunas and floras, rigid adherence to governing policies in the case of the more inviolable areas is to be expected. If an area in a class requiring strict protection must be exploited, then the classification of the area should be appropriately changed. It is to be desired, however, that areas be rated up rather than down in the scale of protection and preservation thereby to augment the relatively few remaining natural areas in the United States.—EMMET T. HOOPER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

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